CAREER PROSPECTS AND RESOURCES OF DOMESTIC ENGINEERING

DOCTORAL STUDENTS

by

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ABSTRACT

Career Prospects and Resources of Domestic Engineering Doctoral Students

by

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Career prospects are a motivating factor for entry and retention of doctoral students, especially in the discipline of engineering. While doctoral student training provides them with highly specialized skills to be an independent researcher, they may not have the requisite skills or guidance to secure the job position of their choice. Therefore, it is important to provide doctoral students with opportunities, training, and information (i.e., resources) about different types of careers to not only ensure they are productive contributors of teaching and research, but also equip them for future career prospects. A synergistic combination of Narrative Inquiry and Action Research combined with a theoretical framework combining Person-Vocation Fit and the Theory of Doctoral Student Development was used to explore how various supports and challenges have contributed to students' intended career paths. Literary coding, discourse, and thematic analysis yielded the emergence of three themes: (1) Engineering Doctoral Identity; (2) Engineering Doctoral Skill Development; and (3) Time. Research emerged as central to engineering doctoral identity and was reinforced by 'Insiders', or people who had a Ph.D. in engineering. Participants' value of research came at the cost of relatively devaluing other skills (e.g., teaching), career functions, and career resources. Depending on the career function participants wanted, they constantly had to negotiate their fit into an engineering doctoral identity and navigate their academic culture. This negotiation influenced the skills they developed and how they crafted tactics to acquire the skills that were not reinforced by structural requirements of their programs or assistantships. While participants negotiated their perceived fit between their chosen vocation and their departmental and institutional cultures, their perceptions and experiences of time shifted between present demands and future career goals. Participants struggled to optimize their time, and consequently utilized Time Adaptive Tactics such as flexibility, networking, and leveraging career resources. Discourse analysis of engineering doctoral and university staff participants revealed that students utilize resources based upon a hierarchy that considers the contextual value and proximity of resources. Additionally, career resources that participants utilized were influenced by Insiders and how they implicitly showed they valued those resources.

(380 pages)

PUBLIC ABSTRACT

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Career prospects are a motivating factor for entry and retention of doctoral students, especially in the discipline of engineering. While doctoral student training provides them with highly specialized skills to be an independent researcher, they may not have the requisite skills or guidance to secure the job position of their choice. Therefore, it is important to provide doctoral students with opportunities, training, and information (i.e., resources) about different types of careers to not only ensure they are productive contributors of teaching and research, but also equip them for future career prospects. Research techniques based upon in-depth narrative interviews and combining research with action were used to explain how doctoral students develop and fit in with their intended careers and was used to explore what supports and challenges contribute to their intended career paths. Analysis of the data revealed three themes: (1) Engineering Doctoral Identity; (2) Engineering Doctoral Skill Development; and (3) Time. Research emerged as central to engineering doctoral identity and was reinforced by 'Insiders', or people who had a Ph.D. in engineering. Insiders' and doctoral students' value of research came at the cost of relatively devaluing other skills (e.g., teaching) and associated career resources. These students had to consider and compromise how they fit within an engineering doctoral identity that is premised on research. This negotiation influenced the skills they developed and how they crafted tactics to acquire necessary skills for future careers. At the same time, participants were struggling to cope with immediate demands of their study while also working towards future career goals. Participants struggled to optimize their time, and in response utilized “Time Adaptive Tactics” such as flexibility, networking, and leveraging career resources. Engineering doctoral student and university staff perceptions of career resources were compared against each other which revealed that students utilize resources based upon a hierarchy that considers how specific and close in time and location those resources are. Whereas staff believed their resources were beneficial regardless of these factors. Additionally, the career resources that participants used were influenced by Insiders and how they implicitly showed they valued those resources.

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Laura A. Gelles

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CHAPTER 1

INTRODUCTION

Doctoral students are an important contributor to the success and productivity of research-intensive universities. In pursuit of their degree, these students are trained to conduct rigorous research to become independent scholars, offer a new perspective needed to advance knowledge, and relied upon for vital teaching and research functions that allow for the high productivity of faculty (Golde & Dore, 2001; Goldman & Massy, 2001). Doctoral education typically follows an apprenticeship model where "students work under the tutelage of their advisors, learning the intricacies of research, and becoming increasingly independent scholars" (Golde & Dore, 2001 p. 5). Recruitment of doctoral students is ultimately limited by financial constraints and structural needs of the department and institution (Goldman & Massy, 2001). However, a common criticism of doctoral programs is that the highly specialized training they provide overproduces Ph.D.s for increasingly competitive academic positions regardless of external labor market conditions (Benderly, 2010; Goldman & Massy, 2001; Nerad, 2004).

Doctoral students have personal motivations for entering a doctoral program that are separate from institutional needs. Research shows that the main motivations to pursue a Ph.D. are career development, interest in a topic or research area, personal motivations, prior experiences, and the influence of others (Brailsford, 2010; Churchill & Sanders, 2007). Career development has been shown to be an important motivating factor for doctoral students (Spaulding & Rockinson-Szapkiw, 2012) and particularly to students in engineering fields who wish to further their career goals (Peters & Daly, 2013). Career prospects are not only a motivating factor for entry into a doctoral program but also an important factor to the retention of doctoral students (Bair & Haworth, 2004; Lovitts, 2001). Average attrition from doctoral programs is consistently estimated between 40-50% (Bowen & Rudenstine, 1992; Lovitts, 2001; Okahana & Zhou, 2017) with attrition from engineering doctoral programs reported as high as 65% (Sowell, 2008). Attrition can occur at all stages due to the many challenges of a doctoral program (Gardner, 2009; Lovitts, 2001) and studies have reported that up to 33% of total attrition occurs after a student reaches candidacy (Golde, 1998). Additionally, a doctoral student's intention to quit has been linked to factors including lack of employability, lack of career prospects, and a poor job market for Ph.D.s (Golde, 2005; Travaglianti, Babic, & Hansez, 2018). This could affect doctoral students who intend to pursue academic and non-academic careers because of the realities of a competitive job market for academic careers or the lack of relevant structured opportunities for professional development for non-academic careers (Denecke, Feaster, & Stone, 2017; Golde & Dore, 2001).

Providing professional development opportunities and career advice and guidance about securing a position after attainment of a Ph.D. typically falls to a student's research advisor or mentor (Carpenter, Makhadmeh, & Thornton, 2015; Edwards & Gordon, 2006; Johnson, 2016; Johnson, Rose, & Schlosser, 2007; Lin & Hsu, 2013). However, doctoral students and recent doctoral recipients have indicated they do not receive adequate or accurate career information before or during their Ph.D. program (Allum, Kent, & McCarthy, 2014). This is especially true for pursuit of careers outside of academia (Denecke et al., 2017; Laursen, Thiry, & Liston, 2012; Roach & Sauermann, 2010). The disconnect between the training and preparation of doctoral students and the careers they ultimately enter and persist in has been well-documented (Council of

Graduate Schools & Association of American Colleges & Universities [CGS & AACU], 2003; Council of Graduate Schools & Educational Testing Service [CGS & ETS], 2012; LaPidus, 1995). While the traditional norm at most research intensive universities is that Ph.D. students are trained and expected to pursue faculty appointments (Gardner, 2009; Gardner, 2010a; Lee, Miozzo, & Laredo, 2010), the realities of the increasingly competitive academic job market (Goldman & Massy, 2001; Nerad, 2004), the observed toll on work-life balance on faculty (Austin, 2002), the increased competition and uncertainty in procuring funding (Cyranoski, Gilbert, Ledford, Nayar, & Yahia, 2011; National Academies of Science, Engineering, and Medicine [NASEM], 2018) and the student's personal career preference (Roach & Sauermann, 2017) can result in pursuit of a non-academic career. Additionally, research has shown that doctoral students' career preference changes throughout the course of their study (Fuhrmann, Halme, O'Sullivan, & Lindstaedt, 2011; Gibbs, McGready, Bennett, & Griffin, 2014; Sauermann & Roach, 2012). This indicates that there may be a "three-way mismatch between student goals, training, and actual careers" (Golde & Dore, 2001 p. 5). This is especially important in the field of engineering where only 14.1% of engineering doctoral recipients reported a definite post-doctoral commitment in academia and 72.9% reported a commitment in industry and business (National Center for Science and Engineering Statistics [NCSES], 2018).

What is evident is that doctoral students are very concerned with their career prospects when considering and persisting in a doctoral program (Golde & Dore, 2001; Goldman & Massy, 2001; Helm, Campa, & Moretto, 2012; Mendoza, 2007; Peters & Daly, 2013; Roach & Sauermann, 2017; Sauermann & Roach, 2012; Travaglianti et al., 2018). By providing information, opportunities to develop transferable skills, and training for all types of careers to these students, they are likely to have the requisite supports to overcome the challenges of their doctoral program and secure a career of their choice (Gardner, 2009). Therefore, it is important to provide doctoral students with opportunities, training, and information (i.e., resources) about all types of careers they intend to pursue to not only ensure they are productive contributors to teaching and research, but also equip them for future career prospects.

1.1 Overview of Methodology

This study is situated on the researcher's positionality that research should be used to enhance practice, promote equity, and improve the lives of the participants. As an engineering doctoral candidate who has experienced both challenges and support during the period of doctoral study, this research acts as a way to ameliorate potential challenges associated with finding a career for other graduate students—particularly in engineering. A combination of two qualitative methodologies—Narrative Inquiry and Action Research—was employed to synergistically explore engineering doctoral student experience situated within their current university context. The focal point of the research will revolve around the experiences or 'stories' of nine domestic engineering doctoral students from four departments within the College of Engineering at Utah State University studied through the methodology of Narrative Inquiry. These nine participants were current and recently graduated domestic Ph.D. students at the time of this study ranging from being within their first semester of doctoral study to having completed all of their degree requirements a few months before data collection began.

Narrative Inquiry was used to inform the Action Research component of the study involving university staff within university offices or engineering departments who have interacted with graduate students either through offering career resources, skill development, or other career related support. By seeking existing career resources and situated, contextual knowledge regarding the provision of career resources to graduate students, a researcher generated compilation of career resources was shared with the engineering doctoral student and interested staff participants. Data was collected from doctoral students via individual semi-structured interviews and from university staff through identification of ‘career resources’ (e.g. documents, webpages) and flexibly through optionally recorded semi-structured interviews or email exchanges. The combination of Narrative Inquiry and Action Research created a space where in-depth contextual information of engineering doctoral students’ needs were contrasted and compared with the current realities that university staff operate within in order to inform a plan of action (Pushor & Clandinin, 2009).

For the Narrative Inquiry aspect of this study, nine current and recently graduated doctoral students from the College of Engineering were purposively selected to participate in this study based on the following criteria: (a) discipline, (b) domestic status, and (c) stage of Ph.D. program. For the Action Research component, recruitment of university staff was purposeful, convenience based, and in consideration of doctoral student participant perception. Criteria for their participation included: (a) being a current or recently retired Utah State University (USU) employee; and (b) employed in their position for more than one year. Action research is research conducted *with* participants and not *on* participants (Cousin, 2009), and thus it requires the active engagement of practitioners which is flexible, cyclical, reflective, and whose process should inform all stages of the research (Kember, 2000). University staff members who have experience within offices within career services or that work with graduate students (e.g., School of Graduate Studies [SGS]) were approached, interest was gaged and cultivated, and flexible levels of participation were made available. This flexible participation varied from identifying relevant resources (e.g. webpages, information), answering questions via email, unrecorded informal interviews, formal recorded interviews, and disseminating a list of pooled career resources generated through this inquiry.

Student data was qualitatively analyzed using literary and *a priori* coding methods and thematic analysis (Berg, 2001; Creswell, 2013; Saldaña, 2016). Following this analysis, staff and doctoral student data was qualitatively analyzed using discourse analysis (Cheek, 2004; Gee, 2010). Discourse acts as a framework to order reality (Cheek, 2004) and when combined with literary coding methods, allows the researcher to "explore underlying sociological, psychological, and cultural constructs" within a narrative (Saldaña, 2016 p. 145). After analysis, student narratives were reconstructed into a single researcher-constructed narrative that combined both student perspectives and the realities of the context they were situated within (Creswell, 2013; Hollingsworth & Dybdahl, 2007; McCormack, 2004a).

The study culminated with an action taken by the researcher to generate and disseminate the career resources to the participants within this study, and future action will (upon approval) include the six GPCs with the College of Engineering disseminating the career resources via email to their current graduate students. Implementation of this action may require further work and individual communication with other important stakeholders such as departmental heads, GPCs, and other administrators.

1.2 Theoretical Framework

This qualitative investigation added to the literature by exploring the various and complicated narratives and journeys of engineering doctoral students as they navigated their disciplinary cultures and professional aspirations while situating their professional needs within the context of their institution. This dissertation was built upon the belief that story is a fundamental representation of human experience, and that narrative is both a method and a phenomenon of study (Pinnegar & Daynes, 2007). Humans, and by extension their stories, are not static or completely knowable. Their aspirations and goals evolve through time and in response to their experience and environment. Thus, this work is grounded in two theoretical frameworks: (a) Gardner's theory of Doctoral Student Development (Gardner, 2009) and (b) Fit Theory which was in the context of doctoral education (Baker & Pifer, 2015).

In Gardner's theory of Doctoral Student Development, doctoral students are often assumed to be "completely self-aware and entirely developed upon entering graduate school" resulting in their needs being overlooked (Gardner, 2009 p. 4). However, these students undergo a complex process of formation that involves the development of expertise, character, and disciplinary role that influences professional preparation and involves development of the whole self (Gardner, 2009). Development occurs as a result of challenges met with requisite supports (Sanford, 1966). There is no shortage of challenges as a doctoral student, but without support these challenges can inhibit development (Gardner, 2009).

Fit Theory describes the construct of a person's 'fit' within the context of an organizational culture (Chatman, 1989; Chatman, 1991). Fit is defined as the "congruence between an individual's personal values and those of the social structure of an organization" which allows for a study of the relationship between a person's attitudes and behaviors and their intended careers (Baker & Pifer, 2015 p. 297). One sub-theory of Fit Theory is Person-Vocation fit which encompasses the positive feelings an individual has towards a profession and the tasks and experiences required for that profession (Baker & Pifer, 2015). In the context of doctoral education, this is the fit with academic experiences and perceived career options (Baker & Pifer, 2015). Using Person-Vocation fit "allows for an examination of the connection between graduate preparation and the varied vocations people consider and pursue upon graduation (Baker & Pifer, 2015, p. 303).

1.3 Purpose of the Study

The purpose of this qualitative study is two-fold. First, it is important to elucidate the types of careers domestic doctoral engineering students are pursuing and to explore how the supports and challenges of their programs have contributed to their intended career path. With career considerations being a factor in both recruitment and persistence in doctoral programs (Helm et al., 2012; Mendoza, 2007; Peters & Daly, 2013; Roach & Sauermann, 2017; Sauermann & Roach, 2012), knowledge of what type of careers engineering doctoral students are pursuing can help faculty, departments, and the institution become more aware of what types of training and resources they should offer to attract and retain graduate students. This is especially important for domestic engineering doctoral students who may be evaluating the relative costs and benefits of pursuing a doctoral degree when they can gain lucrative employment with a bachelor's or master's degree (Peters & Daly, 2013). Secondly, the purpose of this study was to bring about an incremental and sustainable change that benefits not only the participants within this study but potentially a wider pool of engineering and non-engineering graduate students. This approach took an in-depth look at the stories and experiences of engineering doctoral students within the larger context of an individual university to determine how broader university offices (e.g., Career Services) can use their current expertise and resources benefit highly specialized and diverse students.

1.4 Research Questions

This dissertation was guided by the following research questions:

1. What are the perceived career prospects of domestic engineering doctoral students at Utah State University?
2. How do different perceived career prospects (non-academic vs. academic) for engineering graduate students influence the types of supports and resources that are pursued?

1.5 Significance of Study

The collaboration of this engineering doctoral researcher with university staff using the graduate student participants' stories will help facilitate a dialog of graduate student needs with current logistical and realities of the institution in a way that is detailed enough to address the specific and unique needs of engineering doctoral students but broad enough to apply to other graduate students. It is understood that research universities rely on their graduate student population to meet high levels of productivity and address teaching needs (Goldman & Massy, 2001). These students, in turn, rely on the university to provide them with the training and experience that will make them attractive candidates for their respective chosen professions (Golde & Dore, 2001). This work will add to the small body of literature of engineering doctoral students with the intention to empower students through reflection and resources to take agency to improve their lives. While this study makes no claims to creating a fundamental change in the way doctoral students are trained or perceived, it will shed light on any gaps in training and career aspirations for the improvement of doctoral student persistence and outcomes. In particular, this study provided resources on how to develop or market skills that are transferable (e.g. leadership) to non-academic positions and skills that are valued in academia (e.g. teaching) but not as emphasized as research.

1.6 Definition of Key Terms

ABD: An acronym which stands for 'All But Dissertation'. This is a colloquial classification for students who have completed all the requirements of their doctoral program but did not complete a dissertation.

Action research: A research methodology that is pragmatic and flexible that involves research participants as active contributors to the research in order to create a change within an everyday context. Action research is research *with* participants and not *on* participants (Bradbury-Huang, 2010; Brydon-Miller et al., 2003; Case & Light, 2011; Cousin, 2009).

A priori coding: A qualitative coding process where codes are developed before analyzing qualitative data based upon literature, a theoretical framework, or research questions. *A priori* coding provides valuable and targeted analysis about a concept/construct being studied (Creswell, 2013; Saldaña, 2016).

Attrition: When a student enters a degree program but does not complete it. Attrition rates are used as performance indicators for institutions of higher education.

Career Function: The specific tasks, activities, or routines of a job position. Career function are indicative of what an individual is intrinsically interested in and wants to pursue for future employment. Preferred career functions vary by individual and several examples include: research, teaching, service (i.e., helping others/society), and engineering.

Career Sector: A generalized category of where an individual works. Career sectors can encompass a variety of different job positions and require specific skills and proficiencies to be successful. The most typical sought out career sectors for engineering doctoral students are: academia, government research labs, and industry.

Code: A researcher generated construct that is a word or short phrase that "symbolically assigns a summative, salient, essence-capturing and/or evocative attribute to a portion of language based or visual data" (Saldaña, 2016, p. 4).

Code mapping: An iterative method for transition between different cycles of coding in qualitative research that reorganizes and reconfigures data. Code mapping takes all the codes generated in the first cycle of coding and organizes them into categories, then proceeds through several iterations of categorization to begin forming larger themes or concepts (Saldaña, 2016).

Context: The circumstances, conditions, and factors that form the setting for an event, statement, or idea, and in terms of which it can be fully understood and assessed. Context involves an understanding of the specific ways engineering doctoral students are trained, what skills they need for their intended careers, and what values they have (e.g., research, being efficient, optimizing time).

Discourse: Refers to the ways of thinking and speaking about aspects of reality and gives structure to the manner in which a particular topic, object, or process is communicated (Cheek, 2004; Kress, 1985).

Discourse Analysis: A qualitative coding analysis method that is "concerned with how texts have been constructed in terms of their social and historical 'situatedness'" (Cheek, 2004, p. 1144). It is a type of inquiry that assumes that language is not transparent or value free and that the spoken word does not have universal meaning but is assigned meaning by both the speaker and listener in the context of the situation where the language is used.

Doctoral candidate: A classification of a doctoral student based on disciplinary norms. At this stage, the doctoral student has completed all their coursework and successfully passed their qualifying or comprehensive exams. Some departments also require the completion of a dissertation proposal to achieve doctoral candidacy.

Doctoral student: A student at a university with at least a bachelor's degree and possibly a master's degree who is seeking the title of Doctor of Philosophy (Ph.D.). While it varies by discipline (Golde, 2005), this is usually earned through requirements such as taking courses, passing a qualifying or comprehensive exam, proposing, conducting, and defending individual research to a committee resulting in the completion of a dissertation.

Domestic student (U.S.): A student who was born in the United States or has U.S. citizenship and is not pursuing their doctoral study under a temporary visa.

Dramaturgical coding: A qualitative coding method that treats interview narratives as a "social drama" where life is equated to a performance such as a monolog or soliloquy (Saldaña, 2016 p. 145). Dramaturgical coding is a complicated coding method that incorporates several types of coding including: versus coding, values coding, process coding, and emotion coding. Dramaturgical coding requires a researcher to code (1) participant objectives; (2) conflicts or obstacles to objectives; (3) tactics to cope with conflict and achieve objectives; (4) attitudes towards the setting, others, and/or the conflict; (5) emotions experienced; (6) subtext; and (7) characters.

Emergent coding: A qualitative coding approach where codes are not decided beforehand (i.e., *a priori*) and allows for codes and categories to emerge from the data. Emergent coding allows for more flexible qualitative analysis where unexpected results can be considered and incorporated into analysis (Creswell, 2013; Saldaña, 2016).

Engineering doctoral identity: An identity formed through the process of progressing through an engineering doctoral program from being recruited to receiving a Ph.D. Engineering doctoral identity is largely influenced by faculty within their discipline and other individuals seeking or possessing a Ph.D. in their field. This identity is a negotiation of fit between respective values, metrics of success, required tasks, and future goals of individual students and of their department (e.g., faculty, other doctoral students).

Engineering doctoral skill development: The process of attaining and refining skills (e.g., technical, communication, teaching) necessary to be successful as an engineering doctoral student and in a future career. Opportunities to develop skills can be aligned or misaligned with a student's intended career function which can result in restricted skill development or purposeful skill development.

Fit: The alignment between an individual's personal values and those of an organization or structure (Chatman, 1989; Lindholm, 2004).

Fit Theory: A theory used to study the "congruence between an individual's personal values and those of the social structure of an organization" (Baker & Pifer, 2015, p. 297).

Frequency coding: a coding method where the occurrence of codes is counted. Frequency coding can be used to evaluate relevance of a code or compare across participant groups and the co-occurrence of codes.

Graduate Program Coordinators (GPCs): Departmental specific staff who are a link between The School of Graduate Studies and their respective departments. Part of their duties include assisting graduate students with thesis/dissertation requirements and deadlines such as submitting a Program of Study.

Insider: Individuals who have or are seeking a Ph.D. in engineering (e.g., faculty, academics, doctoral students). Insiders define what it means to have a Ph.D. and be accepted and valued in their field. Insiders highly value and reward research prowess, especially in the form of publications in prestigious academic journals. This high valuation of research comes at the cost of devaluing other career functions such as teaching.

Job fit characteristics: Any aspect of a job that aligns or does not align with an individual's personal preferences. In general, if an individual aligns with the various aspects of their job, they will be happier and more productive. Job fit characteristics can range from the type of work (e.g., research) to logistical considerations (e.g., commute).

Literary coding method: A qualitative coding method where qualitative data is analyzed using established methods and approaches for analyzing literature or oral communication. These coding strategies use methods from literary traditions to assign a code to explore underlying sociological, psychological, and cultural constructs (Saldaña, 2016).

Major Professor/Research Advisor: The major professor or research advisor is the primary faculty member who provides guidance to a student on completing a doctoral program. They typically serve as the doctoral student's committee chair and supervisor where the student is employed as their research or teaching assistant. The term of major professor and research advisor (or simply advisor) are often interchangeable and can be specific to certain disciplines. While major professors/research advisors can provide mentoring functions, this role is not synonymous with being a mentor (King, 2003). Mentoring goes beyond providing technical and programmatic guidance to the student and specifically involves providing psychosocial support and intentional career development that are within the mentee's best interest (Johnson, 2002; Schlosser, Lyons, Talleyrand, Kim, & Johnson, 2011).

Memo: A researcher constructed document, email, or informal comment about data collection and analysis. Memos act as a way for a researcher to work towards a solution and help track the evolution of a study (Saldaña, 2016). Memos are the qualitative research equivalent of a lab notebook (Vogt, Vogt, Gardner, & Haeffeke, 2014).

Narrative Inquiry: A qualitative methodology that uses narratives and storytelling to analyze and bring meaning to the experiences of individuals (Clandinin & Connelly, 2000; Creswell, 2013). The process of Narrative Inquiry results in a researcher-constructed narrative developed from the in-depth exploration of participants' stories.

Outsider: Individuals who are outside of engineering academia (e.g., industry, government, family). Doctoral students consider Outsider perspectives throughout their development from recruitment (e.g., cost of pursuing a Ph.D. on family) to the job search (e.g., non-academic employer perception of utility of an individual with a Ph.D. in engineering).

Participant: An individual who agrees to participate within a research study. Participation requires regulatory and ethical approval, is completely voluntary, and can be rescinded by the participant at any time.

Pattern coding: A second cycle qualitative coding method where first cycle coded data is grouped into smaller numbers of categories, themes, or concepts to create a meta code. Similar codes and categories are grouped together to analyze commonality and create meaning and explanations of the data (Saldaña, 2016).

Person-vocation (PV) fit: The relationship or congruence between individuals and their vocations or occupations. If there is an alignment between person and vocation, the individual likely has an awareness of norms of their profession, a connection between skill development and intended career, and support and opportunities to pursue their intended career. Outcomes of PV fit can include increased well-being and career satisfaction (Baker & Pifer, 2015).

Proximity: Nearness in place, time, order, occurrence, or relatedness. Examples of increased proximity to engineering doctoral students include physical location (e.g., labs, engineering buildings), frequency of interaction (e.g., communication with research advisor), and valuation of Insider information and resources (e.g., going to research advisor for career support).

Resources: Information, people, recommendations, trainings, or other assets that can be used to help doctoral students develop the skills needed to become a more attractive candidate for hire in their chosen profession or help them with their job search process. For example: A pamphlet that describes how to transform a curriculum vitae into a resume.

Skill: The ability to perform a task that is necessary to be successful within a context or profession. For example, research skills are necessary to be a successful Ph.D. student.

STEM: Acronym for Science, Technology, Engineering, and Mathematics.

Storymapping: A process that reconfigures extensive participant data into a single narrative. Storymapping begins in the middle of a story (e.g., participant data collection) and informs a logical, chronological sequence of the story (i.e., a beginning and an end) (McCormack, 2004a). Characters, plot, themes, and researcher positionality to the narrative are considered in this process.

Survey of Earned Doctorates (SED): A yearly study conducted by the National Science Foundation that surveys recent doctorate recipients in the United States (National Center for Science and Engineering Statistics, 2018).

Tactics: Specific actions carefully planned to achieve an objective. Tactics reflect participant decisions to pursue or not pursue career resources and how they go about achieving their objectives despite conflicts and challenges (e.g., lack of time).

Thematic analysis: A common qualitative analysis technique that examines and develops patterns of meaning within the data. Thematic analysis identifies implicit and explicit meanings in large data sets and results in winnowing of many individual codes into larger categories (i.e., themes) that reflect a more nuanced and summarized meaning than individual codes (Saldaña, 2016).

Theme: A theme in qualitative analysis is a broader category that codes are organized into that reflects a pattern, trend, concept, or deeper meaning within the data.

Theory of doctoral student development: A theory specific to doctoral students that premises that a student develops as a result of challenges met with adequate supports. The doctoral student experience is arranged into three phases: (1) Entry; (2) Integration; and (3) Candidacy that have respective challenges (e.g., qualifying exam, dissertation) and supports (e.g., research advisor, peers). Doctoral students can move back and forth between the three phases and there is a potential for attrition at each phase (Gardner, 2009).

Time: The indefinite continued progress of existence and events in the past, present, and future regarded as a whole. Time can be perceived and experienced objectively (i.e., Objective Time) or subjectively (i.e., Subjective Time). For Objective Time, time is quantized into absolute measurements and is experienced the same by all individuals (e.g., seconds, days, months, etc.). Subjective Time is an experience and perception of time which is relational and contextual. Units of time are not measured the same by every individual. Experiencing time subjectively means constantly navigating between past memories, present realities, and future expectations (Eldor et al., 2017; Fried, Grant, Levi, Hadani, & Slowik, 2007; Fried & Slowik, 2004;).

1.7 Limitations of the Study

This study is limited in that it is conducted on a narrow population at one institution within the Western United States. The results of this study may not be generalizable to other institutions. However, the findings of this study can be transferable to other institutions and engineering doctoral students. For example, an understanding of the skills needed to be competitive in securing a career (e.g., communication) are important for all fields and all careers. By exploring how current resources in the context of one institution can be tailored to one specific group (i.e., engineering doctoral students), strategies can be developed to apply to other disciplines or contexts to help other graduate students develop these transferable skills. Another limitation of this study was that the researcher assumed that both institutional and/or departmental staff would want to be Action Research partners. From this dissertation, it was evident that staff had varying degrees of interest, time, and resources, which did not necessarily coincide with the limited timeframe of a doctoral dissertation. Additionally, while participants from all disciplines within the College of Engineering were solicited, this does not necessarily reflect all possible career paths, experiences, or needs of all engineering doctoral students at the institution. International students make up over 50% of engineering doctoral students (NCSES, 2018) and they have different needs and considerations during recruitment and pursuing a career in the United States or in their home countries.

Additionally, domestic doctoral students who are underrepresented in engineering likely have disparate needs and experiences within the university.

CHAPTER 2

LITERATURE REVIEW

This literature review provides context to the current state and realities of doctoral education for engineering students while situating that context within the theoretical frameworks of Doctoral Student Development (Gardner, 2009) and Fit Theory (Baker & Pifer, 2015). This chapter contains a synthesis of the current literature related to the structure and function of doctoral programs, doctoral student development, career skills, options, and career choice changes for doctoral students, and Person-Vocation (PV) fit in the context of doctoral education. This extensive review serves to situate doctoral student experiences in chronological order so that their narratives can be analyzed (Clandinin & Connelly, 2000). Lastly, this literature review concludes with a discussion of the career resources that are available to doctoral students to better offer pragmatic solutions to the Action Research aspect of this study (Herr & Anderson, 2015). This literature review also serves to enforce one of five principles of validation in Action Research combined with narratives (i.e. historical continuity) by providing an in-depth description of doctoral programs within the field of engineering (Heikkinen, Huttunen, Syrjälä, & Pesonen, 2012). By studying the realities, challenges, and supports from multiple perspectives, the researcher will better understand the needs and motivations of related stakeholders (e.g. students, faculty, departments, staff) so that a tailored pragmatic action can be taken.

2.1 Structure of Engineering Doctoral Programs

Engineering doctoral programs typically include 1-2 years of discipline specific coursework, experience as a research or teaching assistant, selecting a dissertation advisor, comprehensive or qualifying subject matter examination, formulation of a dissertation project, several years of research training through research assistantships or fellowships, and a final defense of a dissertation (O'Leary, 2016). These programs are typically structured like an apprenticeship where students work and are guided by a primary research advisor who provides information, serves as a role model, and helps socialize the student into their discipline and department (NASEM, 2018; Polson, 2003). Attaining a Ph.D. comes with the assumption that the recipient has in-depth knowledge about a specific discipline and has the capability to independently design and conduct research (Lee et al., 2010). The Ph.D. degree, being a primarily research degree, emphasizes the development of research skills which can sometimes exclude other skills (Golde & Dore, 2001).

Not all doctoral programs are structured the same, especially among different fields (e.g. humanities, education, sciences, engineering, etc.). Several key differences include how students are funded, their interactions with peers and faculty, the training provided, and requirements to graduate (NASEM, 2018). For example, most engineering doctoral students receive tuition waivers and typically work with a supervisor under a research assistantship. While under this research assistantship, doctoral students work in various sized 'labs' made up of other graduate students, undergraduates, and post-doctoral fellows who are supporting the research supervisor. In fields like the humanities, students are more likely to be funded by teaching assistantships or utilize external funding and often work independently to meet the requirements of their programs (Nerad, 2004).

The demographics of the engineering doctoral student population are also unique. Engineering departments recruit a substantial number of international students mostly from countries such as China and India (NCSES, 2018). The latest National Science Foundation (NSF) Survey of Earned Doctorates (SED) reported that temporary visa holders accounted for 51.2% of doctorates received in engineering, while in fields like education or humanities and arts, only 11% and 13% of doctorate recipients were temporary visa holders respectively (NCSES, 2018). In addition, the field of engineering has been historically white and male, and this trend is also evident at the doctoral level where 76.9% of all engineering doctoral recipients are male and 67.2% of domestic doctorate recipients in engineering are white (NCSES, 2018).

Engineering doctoral recipients have a lower time to degree versus all fields (7.3 years vs. 8.8 years) from the start of their bachelor's degree and they are much more likely to have a bachelor's degree in the same field as their doctorate (75.9%) compared to all fields (54.0%) (NCSES, 2018). Over 40% of engineering doctorate recipients reported being married (NCSES, 2018) and about 34% of married engineering doctoral students had spouses who were also students (Nettles & Millett, 2006). Over 80% of engineering doctoral students reported not having children under the age of 18 with women less likely of having children than men (Nettles & Millett, 2006). The majority of engineering doctoral students (70%) reported an individual annual income of less than $20,000 a year when the data was collected in 2001 (Nettles & Millett, 2006 p. 54). The majority of students in all fields of doctoral study reported an income of less than $20,000 except for the field of Education where doctoral students are more likely to have a full-time job while pursuing their degree (Nettles & Millett, 2006, p. 54). There are also differential outcomes of doctoral study based on field including reduced time to degree and higher completion rates for engineering doctoral students (Nettles & Millett, 2006).

Individual departments can also differ in culture, socialization processes, academic rigor, and dissertation requirements (Lovitts, 2001). These differences can manifest in different forms of support and challenges for students. Funding is one of the most important considerations of students in the pursuit of doctoral degrees (Nettles & Millett, 2006). For example, on average, doctoral students in STEM fields like engineering receive more offers of financial support than other fields and graduate with the least amount of debt (Nettles & Millett, 2006; NCSES, 2018). Using data from the NSF's Survey of Earned Doctorates (SED), Zeiser and Kirschstein (2014) found that about 90% of STEM doctorate recipients are primarily funded through institutional funding (i.e. research assistantships, teaching assistantships, fellowships, grants, traineeships) while only 65% of doctorate recipients in fields such as social, behavioral, and economic sciences received institutional funding. They also found that 74% of STEM Ph.D. recipients were primarily funded through research-activities in the form of research assistantships, fellowships, and grants (Zeiser & Kirschstein, 2014). This is also supported by Nettles and Millett's extensive study of doctoral students where they found that research assistantships were the most common source of funding for engineering students (Nettles & Millett, 2006). Additionally, 76% of STEM Ph.D. recipients receive full or partial tuition assistance (Zeiser & Kirschstein, 2014). While pursuing an engineering doctorate may not be as much of a financial burden for students than other fields, domestic engineering students may perceive that burden to be greater when they can pursue lucrative careers in engineering without continuing their education beyond a bachelor's degree (Peters & Daly, 2013).

2.2 Theory of Doctoral Student Development

The theory of Doctoral Student Development (Gardner, 2009) describes three phases within a doctoral program (i.e. entry, integration, candidacy) where students face challenges (e.g. searching for a career) but also support (e.g. advisor) during these phases. This section includes a review of literature involving career prospects as a motivation to pursue a Ph.D. embedded within the first phase (i.e. entry), skills developed during doctoral study embedded within the second phase (i.e. integration), and career choice change embedded within the third phase (i.e. candidacy). Providing a review of career related literature for engineering doctoral students at *all* phases of doctoral study is intended to support the qualitative analysis of the students' narratives and order their experiences chronologically (Chandler & Torbert, 2003; Clandinin & Connelly, 2000).

2.2.1 Student Development Models in Higher Education

Student development in higher education have been well studied and utilized by researchers and practitioners alike. Theories on student development are used to describe, explain, predict, and produce student outcomes as well as assess programs and practices, and generate new knowledge through research (Strayhorn, 2016). These theories have been used to explain psychosocial development (Chickering & Reisser, 1993; Erickson, 1968), cognitive-structural development (Piaget, 1952), social identity development (McEwen, 2005), and moral and ethical development (Kohlberg, 1969). These development theories have also been used to inform theories on the impact of college on students (Astin, 1991; Pascarella & Terenzini, 2005) and individual student success models (Tinto, 1993). Development theories typically describe development as a series of successively more complicated steps or stages that the individual progresses through.

However, criticisms of these theories include that they have been developed by focusing on white males or the traditional eighteen to twenty-year-old, residential, single, full-time undergraduate students (Bloland, Stamatakos, & Rogers, 1994) or that the model places the responsibility for student success solely on the student (Berger & Braxton, 1998). Often graduate students (including doctoral students) are viewed as older undergraduates with similar needs (Arnold, 2014, para. 11). Doctoral students, however, are not a homogenous group. They vary by age and marital status, can have children or other family care responsibilities, and matriculate at different points in their professional career path (Gardner, 2009). Another complicating factor is the relative lack of research on doctoral students (and even less specific to engineering doctoral students) compared to undergraduates. One posited reason for this lack of research is the assumption that doctoral students are viewed not as a student but as a colleague or professional with similar status to faculty and administrators and are already fully developed (Katz & Hartnett, 1976). Comparable to the mentioned theories of student development in higher education, doctoral students also continue to develop as they are socialized within their respective communities (e.g. academic department) and professionally as they learn and develop skills, values, norms, and knowledge relevant to their professional identity (Golde, 1998; McEwen, 2005).

2.2.2 Gardner’s Theory of Doctoral Student Development

The doctoral student development model proposed by Gardner acknowledges and allows for progression and regression within an individual’s professional path along a dynamic series of three phases (i.e. entry, integration, and candidacy) while also accounting for the wide variety of students with accompanying challenges and support where students can “visit and revisit issues and opportunities throughout their programs” (Gardner, 2009, p. 9). This model was created through multiple qualitative studies with 177 doctoral students in various disciplines (including engineering) from various institutions across the United States (Gardner, 2007; Gardner & Holley, 2011; Gardner, 2010a; Gardner & Barnes, 2007; Gardner & McCoy, 2008). This model assumes that development is a result of challenges and supports. For example, if an individual encounters a new situation (i.e., challenge) they respond in a new way which results in development (e.g., skills, knowledge, habits, character). If they do not have adequate support to meet their aggregated challenges, their development is hindered (Sanford, 1966; Gardner, 2009). Figure 2-1 provides an overview of the timeframe, supports, and challenges of the three phases of Gardner’s theory of Doctoral Student Development (2009). Recent graduates were included to represent their inclusion in this dissertation.

2.2.3 Phase I Doctoral Student Development: Entry

The first phase of this model represents the time leading up to admission and beginning of coursework for doctoral students and “greatly affects the rest of their program, solidifies their decision to attend one institution over another, and even influences their decision to persist in doctoral education altogether” (Gardner, 2009 p. 9). While the model lists several challenges including transition, orientation, expectations, and coursework, an important factor in the decision to pursue a doctoral degree is career prospects and meeting career goals (Peters & Daly, 2013; Spaulding & Rockinson-Szapkiw, 2012).

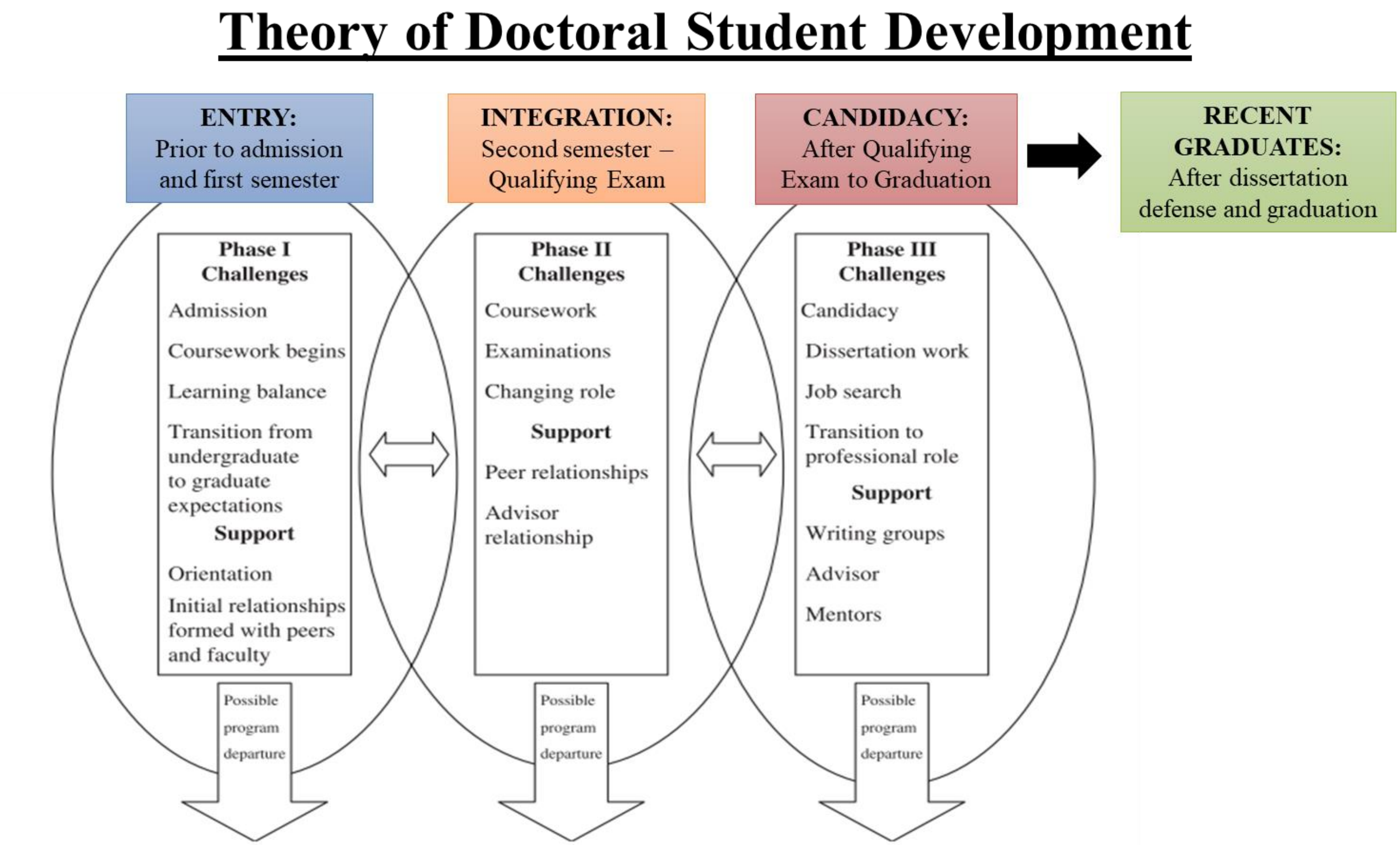


Figure 2-1. Overview of the three phases of Doctoral Student Development (adapted from Gardner, 2009 p. 8)

2.2.3.1 Career Prospects as Motivation to Pursue a Ph.D.

Individually, as students enter a doctoral program, they may have an incomplete idea of what career they wish to pursue upon completion of a doctorate and about the realities of the current job market (Golde & Dore, 2001). In STEM fields, it is typical for doctoral students to pursue their Ph.D. directly after completing their undergraduate degree (Schilling, 2008). About 60% of engineering doctoral students make their decision to pursue a doctoral degree either before or during their undergraduate college years (Nettles & Millett, 2006). This is consistent with the median age of engineering doctoral recipients (30 years), median time to degree (5.3 years from start of doctorate) and median time since completing a bachelor’s degree (7.3 years) (NCSES, 2018). Without adequate information about potential career pathways such as the current positions of engineering doctorate recipient alumni, these direct-pathway students may have an incomplete picture of what careers are available with a Ph.D. (Denecke et al., 2017). In a study of over 4,000 doctoral students in 27 universities across 11 disciplines, the majority of students reported they initially had little information about the job market for Ph.D.s (Golde & Dore, 2001). Information about Ph.D. career pathways such as providing alumni information on departmental websites including an alumni’s current career can act as a support for students in this phase because they will be able to make better and more informed decisions about perceived fit with the program (Allum et al., 2014; NASEM, 2018). Preference for type of career varied by discipline and disciplines with strong connections to industry were shown to have students the least interested in faculty careers compared to other disciplines. (Golde & Dore, 2001). Goldman & Massy’s study found that the chance for industrial employment is also an important motivation for students pursuing an engineering doctorate (Goldman & Massy, 2001). Engineering is a field where industrial employment is common with a doctoral degree. According to the National Science Foundation Survey of Earned Doctorates, 72.9% of doctorate recipients in engineering reported a post academic commitment in industry or business (NCSES, 2018). This percentage has changed little since 1996 (73.0%) (NCSES, 2018) suggesting that pursuing careers in industry or business for engineering doctoral students is a long term and stable trend.

An alternate entry path into an engineering Ph.D. is when an engineering student first enters industry immediately after attaining a bachelor's degree and then later decides to pursue a doctorate. Most returning engineering doctoral students pursue a doctorate because of their perceived utility of the degree to their employment or professional path (e.g. to advance in their career field and increase earning potential) (Peters & Daly, 2013). In a study of 297 direct-pathway engineering doctoral students and 179 returners (students who have a total gap of 5 years or more and are not enrolled full-time in school between completion of their undergraduate and enrollment of their doctoral program), factor analysis revealed that prior to beginning a Ph.D. program, returners perceived they were less likely to attain a Ph.D. and perceived a greater financial, academic, and work-life balance cost than direct-pathway students during their degree (Mosyjowski, Daly, Peters, Skerlos, & Baker, 2017). This investment of students' time and the perception of the added value of a Ph.D. in engineering (especially for those pursuing non-academic paths) "meets the expected return on investment for only a limited number of students" but less so for domestic students (Akay, 2008, p. 408). Akay argued that, for international students, a Ph.D. in engineering earned in the United States "provides entry into a new lifestyle" and a clear monetary reward (Akay, 2008 p. 408). This claim is supported by the statistic that the majority (over 75%) of international students work in the United States after earning their Ph.D. (NCSES, 2018)

Financial considerations are an important factor when pursuing an engineering doctorate because of the availability of lucrative engineering positions with an engineering bachelor's degree. Strikingly, one study estimated that it would take 15 years after attaining a bachelor's degree for an engineering doctorate recipient to match the cumulative earnings of an undergraduate who went directly into an industrial position (Howell-Smith, 2011). These perceived costs and associated challenges can influence an individual's decision to pursue a Ph.D. (Cox et al., 2010; Howell-Smith, 2011; Mosyjowski et al., 2017). Additionally, in a qualitative study of engineering education researchers with expertise in studying graduate students, Cox and colleagues found that perceived economic climate contributed to recruitment and retention of engineering doctoral students and many potential students are unwilling to invest the time required to enroll full-time in a Ph.D. program (Cox et al., 2010).

2.2.4 Phase II Doctoral Student Development: Integration

The second phase of Gardner's doctoral student development model is Integration (Gardner, 2009). This phase is characterized by social and academic integration into a department and discipline while the student is completing their coursework and preparing for examinations to attain candidacy. In this phase, students face the challenge of demonstrating their competency and socialization. This includes learning the realities of being a graduate student and mastering the skills that are crucial to their success as a student such as research and academic writing (Golde, 1998). This socialization into their discipline and academic department can occur through both formal and informal rules and expectations (Mendoza, 2007). Implicit and explicit messages about what is important and qualifies as being successful and prestigious within their field are communicated within these academic cultures (Gardner, 2009; Lovitts, 2007). In a study of women graduate students in science and engineering, hidden expectations and norms were explored within the research-advising relationship. These graduate students reported feeling an implicit expectation to pursue an academic career even if this was not their intended career path (Gelles, Villanueva, & Di Stefano, 2018; Villanueva, Di Stefano, Gelles, Vicioso, & Benson, 2019). These expectations to pursue a particular career path are reinforced by the training and opportunities provided within a doctoral program (Golde, 2005).

2.2.4.1 Skills Developed During Doctoral Study

The knowledge and skills acquired during an individual's doctoral study are important for a student's future career prospects (Berdanier, Branch, London, Ahn, & Cox, 2014; Berdanier, Tally, Branch, Ahn, & Cox, 2016; Cox et al., 2011; Lee et al., 2010; NASEM, 2018; Zhu, Cox, Branch, Ahn, & London, 2013). During the Integration phase of Doctoral Student Development, students develop the skills and competencies needed to be successful as an academic and researcher in their field (Gardner, 2009). This is accomplished through structured activities such as coursework, research or teaching assistant experience, and examinations (Gardner, 2009). To be successful in these activities requires the student to develop a deep specialized expertise in their field and to develop technical skills such as designing experiments, statistical analysis, data analysis, developing procedures, modeling, and computational techniques (Lee et al., 2010;

NASEM, 2018; Watson & Lyons, 2011). It is also imperative that students develop problem solving skills, critical thinking skills, and the ability to work independently (Denecke et al., 2017; NASEM, 2018; Watson & Lyons, 2012). However, students may need additional development of the skills, knowledge, and competencies required to be successful in their chosen profession. Unfortunately, research has shown that doctoral students with both academic and non-academic career prospects have reported not being adequately prepared to pursue those careers because of various factors including lack of skill development (Akay, 2008; Berdanier et al., 2014; Golde & Dore, 2001; Helm et al., 2012; Tsugawa-Nieves et al., 2017; Watson & Lyons, 2011).

Doctoral students who are pursuing academic careers develop the highly technical, discipline specific skills needed for their intended career, but they are still not adequately prepared to attain an academic position upon graduation (Denecke et al., 2017; Watson & Lyons, 2011). In a survey of 67 engineering Ph.D. students at a research-intensive university in the Midwest, the authors found that both industry-bound and academia-bound engineering doctoral students perceived gaps in the skills they needed and the connection of these skills to their chosen profession (Berdanier et al., 2014). While the study showed that these academia-bound students had a better understanding of what it took to excel in their chosen career compared to industry-bound students, academic-bound students perceived a skill gap in bringing in outside funding, developing and managing budgets, and teaching academic courses (Berdanier et al., 2014). Other studies have also found a need for further development of grant writing and teaching skills for academia-bound doctoral students (Austin et al., 2009; Denecke et al., 2017; NASEM, 2018; Watson & Lyons, 2011). Additionally, the literature also suggests that engineering doctoral students are also insufficiently prepared in group management and engaging in interdisciplinary collaborations in academia (Austin et al., 2009; Golde & Dore, 2001).

Doctoral students pursuing non-academic positions such as those in industry or government also report a lack of preparation for pursuing their chosen career (Berdanier et al., 2014; Denecke et al., 2017; NASEM, 2018). Non-academic employers of engineering Ph.D. holders have stated that Ph.D. students are “trained too narrowly and lack key professional skills” (Akay, 2008, p. 406). These employers have particularly noted that these students have a deficit of skills related to data science, big data skills, science policy, governance, risk, compliance, time management, and project management (Denecke et al., 2017). Doctoral students are also aware of a deficit in their skills relative to the expectations of their chosen career path. In a study of 109 engineering Ph.D.s working in non-academic fields, Watson & Lyons asked their participants what skills were important for entry level non-academic engineering Ph.D. positions and their preparation level upon graduating. They found that graduate students felt underprepared for working in teams, following safety and environmental regulations, understanding intellectual property processes, scaling up systems, and identifying customer needs while they were over prepared for working independently, reviewing literature, writing peer reviewed papers, and mentoring others (Watson & Lyons, 2011). In another study, engineering doctoral students pursuing industry careers reported a gap in their level of preparation specifically communication, working across disciplines, and working in teams (Berdanier et al., 2014). Denecke et al. (2017) has suggested that students pursuing non-academic careers may need to further develop leadership and economic skills such as project management, developing budgets, and understanding commercial implications of research.

Skills needed for academic and non-academic careers are not mutually exclusive. Skills valuable in all professions can include communication, leadership, teamwork, personal skills, economic/commercial skills, and adherence to organizational culture (Denecke et al., 2017; Lee et al., 2010; NASEM, 2018; Watson & Lyons, 2011; Watson & Lyons, 2012). Doctoral students should be able to translate and adapt the experiences and skills learned in an academic and experiences for any employment setting (Lehker & Furlong, 2006). Alternatively, doctoral programs may not offer opportunities to develop these skills (Denecke et al., 2017). Thus, doctoral students “struggle to articulate the skills they acquire during their Ph.D.” (Metcalfe & Gray, 2005, p. 11). The skills needed for engineering doctoral students for all types of careers according to the literature are synthesized in Table 2-1. These skills represent areas that training and documents (i.e. resources) can be tailored to better prepare a doctoral student for their intended career path.

Table 2-1. Skills and competencies needed for engineering doctoral students for all careers.

Type of Skill	Definition	Literature Sources
Technical (TECH)	Techniques that are required to conduct research effectively. These can include designing experiments, computational research, modeling, developing and using specific techniques or computer programs, deep knowledge in a content area, data analysis, procedure development, testing hypotheses, technical competency, mastery of engineering, science, and math fundamentals, and employing rigorous research methods.	Ahn, Cox, London, & Zhu., 2013; Akay, 2008; Berdanier et al., 2016; Cox et al., 2011; Craswell, 2007; Denecke et al., 2017; Lee et al., 2010; NASEM, 2018; Nyquist & Wulff, 2000; Watson & Lyons, 2011; Watson & Lyons, 2012
Problem solving (PROB)	The ability to define a problem, break it into parts, and customize a solution depending on the context.	Ahn et al., 2013; Akay, 2008; Denecke et al., 2017; Lee et al., 2010; NASEM, 2018; Watson & Lyons, 2011
Critical and analytical thinking (THINK)	Objective analysis and evaluation of a situation or problem in order to form a judgment.	Denecke et al., 2017; Cox et al., 2011; Watson & Lyons, 2012
Teaching (TEACH)	The ability to impart knowledge or skill to someone. These skills include: preparing a class, developing curriculum, presenting, grading, and training others.	Ahn et al., 2013; Adams, 2002; Akay, 2008; Berdanier et al., 2016; Cox et al., 2011; Denecke et al., 2017; Helm et al., 2012; NASEM, 2018; Nerad, 2004; Zhu et al., 2013
Leadership (LEAD)	The ability to guide or direct a group. These skills include: project management, networking, managing people, conflict management, time management, team-building, motivating others, supervising others, and administrative skills.	Ahn et al., 2013; Akay, 2008; Berdanier et al., 2016; Cox et al., 2011; Denecke et al., 2017; Helm et al., 2012; NASEM, 2018; Nyquist & Wulff, 2000; Watson & Lyons, 2011; Zhu et al., 2013
Communication (COMM)	The ability to convey information to an audience. These skills include: written (e.g. reports, emails, memos), oral (e.g. presentations, phone), and interpersonal communication. This also includes the ability to tailor information to non-academic and non-technical audiences.	Ahn et al., 2013; Akay, 2008; Berdanier et al., 2014; Berdanier et al., 2016; Cox et al., 2011; Denecke et al., 2017; Evans, Beakley, Crouch, & Yamaguchi, 1993; Griffin & Hauser, 1992; Helm et al., 2012; NASEM, 2018; Nyquist & Wulff, 2000; Watson & Lyons, 2011; Watson & Lyons, 2012; Zhu et al., 2013

Table 2-1 (continued).

Interpersonal (INTERP)	The ability to interact with others harmoniously. Attributes of this skill include: possessing empathy, emotional intelligence, resilience, knowledge of social expectations and customs, and passion.	Denecke et al., 2017; Nyquist & Wulff, 2000; NASEM, 2018
Teamwork and Collaboration (TEAM)	The cooperative effort of people in a group who work together. These skills include: working with others including in multi, cross-, inter-, and trans-disciplinary contexts and cultural competency.	Ahn et al., 2013; Akay, 2008; Austin et al., 2009; Cox et al., 2011; Denecke et al., 2017; Helm et al., 2012; NASEM, 2018; Nerad, 2004; Watson & Lyons, 2011; Zhu et al., 2013
Organizational Culture & Ethics (ORG)	The ability to adhere to standards of personal and disciplinary behavior, values, and guiding principles. This includes adherence to institutional mission or organizational culture, knowing the field, and knowledge and adherence to professional codes of ethics, and environmental and safety regulations.	Ahn et al., 2013; Akay, 2008; Berdanier et al., 2016; Denecke et al., 2017; Helm et al., 2012; NASEM, 2018; Watson & Lyons, 2011; Watson & Lyons, 2012
Economic and Commercial (ECON)	The ability to incorporate economic and commercial factors into problem solving and decision-making. These skills include: budget-making, economic analysis, cost-benefit analysis, understanding commercial implications of research, marketing products, identifying customer needs, protecting intellectual property, and translating research findings to business applications.	Ahn et al., 2013; Berdanier et al., 2016; Cox et al., 2011; Watson & Lyons, 2011; Watson & Lyons, 2012; Zhu et al., 2013
Securing funding (FUND)	These skills are those needed to secure funding at an organization. Examples of these include: grant writing and entrepreneurship.	Austin et al., 2009; Berdanier et al., 2014; Cox et al., 2011; Denecke et al., 2017; Nerad, 2004; Watson & Lyons, 2012
Working independently (IND)	The ability to work with little guidance and think independently.	Berdanier et al., 2014; Cox et al., 2011; NASEM, 2018; Watson & Lyons, 2012

2.2.5 Phase III Doctoral Student Development: Candidacy

The last phase of Gardner's doctoral student development model is Candidacy (Gardner, 2009). This phase is characterized by the student conducting independent research in the form of a dissertation. In this phase, students face the challenges of completing a dissertation, the job search, and transitioning to a professional role. This phase is typically where doctoral students begin their job search, which compounds upon the stress of completing a dissertation (Gardner, 2009). Searching for a job is time consuming. In addition, uncertainty about the future can be a major source of stress for students (Golde & Dore, 2001). If students feel positive about their career prospects they are "significantly happier and less depressed than students who don't" (U.C. Berkeley: The Graduate Assembly, 2014, p. 2). Additionally, students are more likely to make timely progress towards their degree if they feel confident about securing a position after graduating (Espaldon, 2016). Unfortunately, the competitive job market for academic positions can be overwhelming and discouraging for some doctoral students (Golde & Dore, 2001). While the overall number of STEM Ph.D. recipients has increased, the number of tenure-track positions has remained relatively constant leading to a surplus of candidates for academic positions (Xue & Larson, 2015). Often, students seeking academic positions must first accept temporary positions with less benefits such as post-docs or adjunct positions to attain the necessary publications and experience to be competitive (Lee et al., 2010; Nerad & Cerny, 2002; Nerad, 2004). In Conti & Visentin's study of 2,356 science and engineering Ph.D.'s at two European universities, they found that 93% of students in academic positions after the completion of their Ph.D. started in a post-doctoral position (Conti & Visentin, 2015). This suggests that Ph.D. students need more time to develop additional skills or qualifications and create a competitive curriculum vitae to be competitive in the academic job market.

The ambiguous and difficult nature of the dissertation and job search can result in feelings of not moving forward or being stuck (Devos et al., 2017). Students have reported feeling too overwhelmed by their work to engage in their job search (Helm et al., 2012). In another study of 160 Ph.D. candidates from Belgium that assessed their intention to quit their program using needs-supplies Fit Theory, the authors found that lack of support from their research supervisor, job insecurity, lack of development to increase employability, and lack of career prospects affected Ph.D. students' intention to quit (Travaglianti et al., 2018). Alternatively, in a study of 3,659 Ph.D. students across disciplines in Belgium, Levecque, Anseel, De Beuckelaer, Van der Heyden, & Gisle (2017) observed that Ph.D. students who perceived that a Ph.D. sufficiently prepared them for their desired career choice and felt their degree added value to their future employers was associated with better mental health outcomes. Thus, it is important to provide resources to doctoral students to assist them in securing the career of their choice.

2.2.5.1 Career Choice Change During Doctoral Study

To further complicate this issue, an engineering doctoral student's career choice may not be stable throughout the course of their doctoral program (Fuhrmann et al., 2011; Sauermann & Roach, 2012; Roach & Sauermann, 2017). This change has been shown to occur at the third year of doctoral study across all disciplines and was attributed to direct work experience, exposure to the work of faculty, perception of work-life balance, and the realization that there are more options than academia (Helm et al., 2012). This third year of doctoral study is typically associated with candidacy (Gardner, 2009). Research has shown that academic research careers are initially highly regarded by science and engineering doctoral students (Golde & Dore, 2001; Sauermann & Roach, 2012). However, several studies have shown that career preference of doctoral students' changes throughout their academic career (Fuhrmann et al., 2011; Helm et al., 2012; Mendoza, 2007; Roach & Sauermann, 2017; Sauermann & Roach, 2012). In Sauermann & Roach's study of 4,109 life science, chemistry, and physics Ph.D. students at 39 research institutions, they found that interest in academic research careers declined over the course of their Ph.D. training while interest in other careers such as industrial positions increased. Even when students were asked to ignore factors such as availability of faculty positions, interest in faculty research careers still dropped across all disciplines studied (Sauermann & Roach, 2012). They attributed this drop-in interest to being unable to divorce themselves from the competitive realities of the academic job market and witnessing firsthand the realities of being in a faculty position from their advisor. Roach and Sauermann's 2017 longitudinal study of 854 Ph.D. students in life sciences, chemistry, physics, engineering, and computer science found similar results where career goals change throughout doctoral studies and that a "substantial share of Ph.D. students lose interest in an academic research career for reasons other than labor market conditions" (Roach & Sauermann, 2017 p. 20). They also found that U.S. citizens are significantly more likely to lose interest in academic careers than international students over the course of their study (Roach & Sauermann, 2017). While Roach and Sauermann did not offer an explanation for this, domestic students may perceive they have more access to alternative career options in the United States than international students.

2.2.6 Summary of Doctoral Student Development

It is important to understand how career perceptions and choices shift and change throughout an engineering doctoral student's career. Their motivations for entering a program are not static, the skills they develop during integration can help prepare them for their future careers, and their collective experiences before and during candidacy can possibly result in a change in career choice. Section 2.2 suggested that career prospects and considerations are important throughout all the phases of doctoral student development. This dissertation proposes that inherent in this developmental process of doctoral students is a constant negotiation between a doctoral student's identity within their academic departments and their intended future career. Thus, Fit Theory (Baker & Pifer, 2015) was chosen as part of the theoretical framework.

2.3 Fit Theory

Fit Theory has been used to explain students' persistence in academic programs (Lindholm, 2003) and how complex interactions between a doctoral students' environment affect their career decision-making (Lindholm, 2004). Of the many types of fit that can occur in a work environment, Person-Vocation fit is the relationship between individuals and their vocations or occupations (Holland, 1985). The fit between a person's interests and vocation has been studied extensively (Tranberg, Slane, & Ekeberg, 1993; Kristof-Brown, Zimmerman, & Johnson, 2005) and Person-Vocation congruence (i.e., fit) has been correlated with individual measures of well-being and career satisfaction (Rounds & Tracey, 1990). Theory and research support the idea that people choose work environments that are a good fit between their interests and characteristics and that of their occupation (Holland, 1996). Another aspect of PV fit is the theory of work adjustment, which proposes that a person will persist in a profession if there is a congruence between the individual and their work environment (Dawis & Lofquist, 1984).

While PV fit has not been used to study doctoral students, Baker & Pifer proposed that using PV fit in the context of doctoral study “allows for an examination of the connection between graduate preparation and the varied vocations people consider and pursue upon graduation” and is particularly useful for research about doctoral students with diverse career paths (Baker & Pifer, 2015, p. 303). They proposed that the possible antecedents of PV fit are understanding the roles, responsibilities, and reward structures of intended career paths, connection of skill development and practice, support and opportunities to practice professional roles, and faculty and peer mentors. The possible positive outcome of PV fit include engagement in professional practices, advancement, and persistence. Possible negative outcomes include failure to obtain employment and relevant support or training for career goals (Baker & Pifer, 2015). Ward and Brennan have built upon this framework by proposing an analytical model of doctoral student Fit (2018). In their model, PV fit has two sub-dimensions: (1) student-motivation fit; and (2) student-learning environment fit. They postulated that PV misfit factors include: (a) lack of interest in research; (b) perceived value of doctoral qualification diminished; (c) doctoral course scheduling difficulty; (d) insufficient research training; and (e) negative pressure to publish research (Ward & Brennan, 2018). By applying Fit Theory, and particularly PV fit, to study doctoral education, researchers will “better understand the variety of factors that influence doctoral students' development perceptions within the context of their educational experiences” (Baker & Pifer, 2015, p. 305).

2.4 Career Resources

Information, resources, and mentoring for pursuing a career after attaining a doctorate are typically thought of as the responsibility of the individual student's faculty advisor (Carpenter et al., 2015; Edwards & Gordon, 2006). However, faculty may be unable or unwilling to provide this guidance due to lack of information or the time burden they already face in their daily lives (Council of Graduate Schools [CGS], 2018). Departments can also play a role in professional development opportunities such as connecting alumni to current students, teaching assistantships, grant-writing training, and facilitating networking opportunities (O'Meara et al., 2014). For example, a department may provide up to date career information on their alumni or bring these alumni back to campus to meet current students (Allum et al., 2014; Denecke et al., 2017). Each department, however, is unique and may or may not offer or encourage participation in professional development opportunities.

There are career resources at the university level that a student can utilize (Lehker & Furlong, 2006). Helm et al. (2012) recommended that tailored career services should be provided through a centralized location such as a Graduate School and not to rely exclusively on faculty (Helm et al., 2012). A 2017 report from the Council of Graduate Schools (CGS) reported that many universities offer students the opportunity to develop skills and competencies in addition to those learned through their Ph.D. study, but that students had difficulty discovering and utilizing these opportunities (Denecke et al., 2017). Additionally, this report found that the majority (60%) of graduate student professional development programs are funded by Graduate Schools and that career services was a key partner involved in graduate student development (Denecke et al., 2017). Even when these non-departmental career resources are offered, graduate students may not pursue them if they are not designed specifically for them (Lehker & Furlong, 2006). Graduate students have different needs than undergraduates and “might be wary of an office or a service that does not recognize their unique perspective” (Lehker & Furlong, 2006 p. 75).

Other barriers to seeking out these resources include: lack of awareness, scheduling, and perception of an advisor’s lack of support for pursuing these resources (Denecke et al., 2017). STEM students have reported not feeling comfortable pursuing courses, workshops, or other professional development opportunities that did not relate to their advisor’s research because they were afraid it might put their relationship at risk (Denecke et al., 2017; Laursen et al., 2012; NASEM, 2018; Wisniewski & Robles, 2017). This stigma, whether perceived or real, is subtly enforced by a research advisor’s preference for their doctoral students to pursue academic positions due to reward structures at research universities (Gardner, 2007). Additionally, Golde and Dore’s study found that that students reported that the most widely available professional development opportunities are related to teaching (Golde & Dore, 2001). Thus, even if resources are offered and supported, they may not serve non-academic career paths.

Given all these challenges, graduate students also have a responsibility to seek out these resources. They are ultimately responsible for finding a post-graduation career. The culmination of a Ph.D. program results in a student becoming an independent researcher (Golde & Dore, 2001). Likewise, students must independently pursue their desired careers. This does not mean they do not need support at all phases of their development. By strategically providing support, a doctoral student’s sense of agency in pursuing their career can be increased (O'Meara et al., 2014). Information about Ph.D. career pathways was found to empower students and increase their perceived fit within a program upon entrance (Allum et al., 2014). In O'Meara and colleagues' study of 884 STEM doctoral candidates they found that their participants linked the sense of agency they felt in achieving their career goals to tangible resources that were provided to them (O'Meara et al., 2014). By identifying, compiling, and strategically providing the resources specific to these students, current and future students interested in all types of careers can benefit.

2.5 Summary of Literature Review

This literature review has provided an in-depth look at how engineering doctoral student's career prospects fits within the frameworks of Doctoral Student Development (Gardner, 2009) and Fit Theory (Baker & Pifer, 2015). As doctoral students progress throughout the three phases (i.e. entry, integration, and candidacy), their career related motivations shift and evolve as they are socialized within their disciplines, develop the skills needed to be successful doctoral students, and are confronted with the realities of academia (Gardner, 2009; Weidman, Twale, & Stein, 2001). Pursuit of a doctorate results in developing expertise in a discipline and corresponding research skills (Lee et al., 2010; NASEM, 2018). These skills, however, may not correspond to the careers or vocations that graduate students want to pursue. This can result in decisions to pursue different careers (Sauermann & Roach, 2012; Roach & Sauermann, 2017) or, in some cases, attrition (Travaglianti et al., 2018). By considering a doctoral student's Person-Vocation fit, a better understanding of the factors that influence doctoral students' development can be achieved (Baker & Pifer, 2015). The combination of Fit Theory and doctoral student development has not been used to study the experiences of engineering doctoral students.

This synergistic combination allows for a more strategic analysis of student experiences and narratives and to order their stories chronologically within Narrative Inquiry (Clandinin & Connelly, 2000).

Lastly, career resources can be provided to doctoral students by advisors, departments, and their institutions. There are several barriers to providing training and other resources for non-academic careers through research advisors and departments (Gardner, 2007; Golde & Dore, 2001). Institutional offices like Graduate Schools and Career Services have been shown to provide many important career resources for graduate students (Allum et al., 2014; Denecke et al., 2017). However, there are also barriers for students individually seeking out these resources including lack of awareness of some career resources and perception that existing career resources are exclusively for undergraduate students (Lehker & Furlong, 2006). Each department and institution is structured differently. Thus, it is important to tailor pragmatic solutions to the unique context of a university. By understanding how doctoral students develop and how their skills fit into their preferred career path, current university resources can be strategically utilized to further develop these skills.

CHAPTER 3

METHODS

At the doctoral level, disciplinary cultures across institutions, colleges, and even research groups are unique (Gardner, 2009). Reports about Ph.D. recipients in science and engineering (NCSES, 2018), career pathways (Allum et al., 2014), and on the state of graduate STEM education (NASEM, 2018) have provided a broad overview and generalizations about doctoral recipients within STEM fields like engineering. For example, the Survey of Earned Doctorates (SED) has reported that engineering doctoral recipients consistently have the lowest rates of academic appointments compared to other science and non-science and engineering fields (NCSES, 2018). While these generalizations are important, broad approaches and strategies based on these generalizations have been proven to be ineffective at addressing the individual needs of students who have diverse career options and interests (Denecke et al., 2017). These doctoral students have variable expectations, requirements, financial support, socialization, interactions with peers and faculty, access to mentors, and definitions of research productivity (Nettles & Millett, 2006). As with the programs they enter, doctoral students bring different experiences, characteristics, and goals to their programs. These students can vary in age, professional experience, marital status, and family responsibilities (Gardner, 2009; Nettles & Millett, 2006; Polson, 2003). This combination of individual characteristics and disciplinary, environmental, and cultural differences of students demands the need for a granular approach using highly contextual research to take meaningful action to adequately meet the needs of doctoral students.

This dissertation used two highly contextual and collaborative qualitative research methodologies (i.e. Narrative Inquiry and Action Research) to engender a dialog between two groups of interested stakeholders (i.e. engineering doctoral students and university and departmental staff) at Utah State University with the intention of creating a space for meaningful action. The level of action taken by the staff participants was dependent on the relationship built with them, their interest and time, and the realities of their profession. Potential action strategies were facilitated by institutional and departmental staff who were approached based on the services they offered, their expertise in providing relevant guidance related to the topic or population, and their perceived interest. Staff participation in this study was dependent on identifying career resources on campus that were then compiled and disseminated to the engineering doctoral student participants in this study. Further dissemination endeavors will have to be negotiated with the staff participants and/or administration and other important stakeholders from engineering departments.

If university staff are unable or unwilling to disseminate the compiled list of resources generated through this dissertation, the researcher will approach the Graduate Programming Coordinators (GPCs) within each of the five departments in the College of Engineering and ask them to disseminate these career resources to their current graduate student population with prior approval. GPCs are departmental specific staff who are a link between the School of Graduate Studies (an office that deals with graduate students) and their respective engineering departments. These GPCs are an ideal alternative for dissemination because they already have information about their department's current graduate student population. The GPCs have already been informally contacted via individual conversations using the Engineering Education GPC as the first gatekeeper. Gatekeepers are an integral part of the research process prior to beginning a qualitative study because they help researchers "gain local permission from site and participants" (Creswell, 2013 p. 58). The engineering GPCs identified and introduced through the engineering education GPC have indicated their willingness to disseminate the career resources upon completion of this study.

Lastly, this dissertation makes no claim of studying the efficacy of the eventual action taken; its intention is to use the empowering and collaborative principles of Action Research and the highly contextual narratives of engineering doctoral students to bring attention to the individual experiences of graduate students in hopes of creating a dialog and site for future action. By studying the individual narratives of engineering doctoral students and connecting them in the context of their university and the specific challenges and supports offered, there is potential for meaningful action that could build an incremental and sustainable change.

3.1 Research Questions

There are two research questions for this dissertation. The first will focus primarily on the narratives of engineering doctoral students who will be asked about their career prospects. The second question will use the engineering doctoral student narratives in context of the institution to explore the interaction of specific student career resource needs to the current realities of the institution. By doing this, these two realities can be brought together in a dialog to enact an incremental change that benefits graduate students.

1. What are the perceived career prospects of domestic engineering doctoral students at Utah State University?
2. How do different perceived career prospects (non-academic vs. academic) for engineering graduate students influence the types of supports and resources that are pursued?

3.2 Interpretive Framework

In qualitative research, the researcher is closely involved in the data and acts as a research instrument or subjective lens through which data is analyzed (Creswell, 2013; Given, 2008). Because the researcher is a critical part of the data analysis, it is important to elucidate what philosophical assumptions they are interpreting the data through. Philosophical assumptions implicitly inform choice of theories and guide research (Creswell, 2013; Denzin & Lincoln, 2011) and are engrained in an interpretive framework which forms the "basic set of beliefs that guide action" (Guba, 1990, p. 17). This dissertation uses an Ontological philosophical assumption (Creswell, 2013). Multiple realities can coexist within a single context using an Ontological philosophical assumption and these multiple realities are seen through multiple perspectives (e.g., participants, researcher) (Creswell, 2013). Multiple forms of evidence with a specific focus on the "actual words of different individuals" support the existence of different realities (Creswell, 2013 p. 20). This Ontological assumption is set in the framework of dialectics. Dialectics is a dialog between two or more standpoints about a subject with the intention of establishing truth through reason (Greene & Hall, 2010). Dialectics is premised on the belief that human phenomena are complex and better understanding derives from multiple perspectives (Greene & Hall, 2010). Additionally, a dialectic framework believes that divergent or dissonant inquiry results are held with equal regard and that this leads to new insights and perspectives (Greene & Hall, 2010). As a doctoral candidate within the College of Engineering, my perceptions of career resources may closely mirror those of the doctoral student participants, which may come at the cost of understanding differing perspectives of career resources at Utah State University. Thus, using this interpretive framework of Ontology with Dialectics is necessary to give equal weight to alternative realities in order to not over-privilege doctoral student accounts over staff data.

3.3 Researcher Positionality

First and foremost, I acknowledge that I am an engineering doctoral student who has spent considerable time considering, exploring, and worrying about what career path I will pursue and how to maximize my experiences to be qualified for that career. The literature review for this study has shown that other engineering doctoral students perceive limited options and acceptance of career paths before and during their doctoral study. Before I entered my Engineering Education program, I also had this perception of one possible career path for Ph.D. holders (i.e., academic). During my recruitment visit to the university, I mentioned this concern and made it clear I had little interest in a tenure-track or teaching position. It was the reassurance and specific career examples I received from my Ph.D. advisor that solidified my decision to pursue a doctorate. in Engineering Education. Even throughout the other phases of doctoral development, my advisor has given me the mentoring, support, resources, and opportunities to develop the skills needed to pursue a career outside of academia. Without the continual acceptance, support, and intentionally in provided opportunities (e.g., internships), I may not have entered or persisted in this program.

As excellent as the support of my advisor and other mentors has been, I am concerned that my experience may be the exception, and not the norm. It is this concern that has fueled my research in this and similar topics. As a doctoral candidate, I have perceived an expectation or preference for academic careers. I acknowledge that messages that are received are often not those that are intended. Adding to this, I believe that by considering how multiple stakeholders makes sense of and communicate their experience or ‘stories’, analyzing that discourse, and bringing stakeholders into a meaningful and non-accusative dialog, sustainable and incremental change can be made.

Secondly, the unique structure of this dissertation (which is traditionally a rite of passage for academics) is being used to gain competency in skills that will benefit my preferred career path. I believe that a doctoral student is ultimately responsible for their future, but they should also be given the support and resources to pursue that future. Thirdly, this dissertation hopes to push the boundaries of the field of Engineering Education and to prove that incremental change (however small) is possible for a single student to make.

3.4 Participants

There were two research populations for this study. The first research population was nine domestic (U.S. citizens) doctoral students in the College of Engineering (i.e., Mechanical & Aerospace Engineering, Civil Engineering, Environmental Engineering, and Engineering Education). The second research population is currently employed USU institutional and departmental staff who provide career resources (e.g. information, documents, training. mentoring) or have professional responsibilities towards graduate students at USU.

3.4.1 Engineering Doctoral Student Participants

Nine domestic doctoral students were recruited from the College of Engineering at Utah State University to participate in the Narrative Inquiry aspect of this study. Participants from four disciplines within the College of Engineering agreed to participate which included Mechanical and Aerospace Engineering, Civil Engineering, Environmental Engineering, and Engineering Education. These participants are summarized in Table 3-1 and given an identifier to help preserve their confidentiality.

Table 3-1. Summary of domestic engineering doctoral student participants.

Participant	**Development Phase**	**Source(s) of Funding**	**Master's degree**	**Master's degree in same field as Ph.D.**
DS #1	Candidacy	Fellowship or grant, RA, TA	Yes	Yes
DS #2	Candidacy	RA	Yes	No
DS #3	Recent Graduate	Fellowship or grant, Employed outside of the university	Yes	No
DS #4	Entry	RA	Yes	No
DS #5	Recent Graduate	Fellowship or grant	Yes	No
DS #6	Integration	RA	Yes	Yes
DS #7	Integration	Fellowship or grant	Yes	Yes
DS #8	Integration	Fellowship or grant, RA, TA	No	N/A
DS #9	Integration	RA, TA	Yes	Yes

Note. RA= Research Assistantship, TA= Teaching Assistantship

Narrative inquiry typically analyzes the in-depth experiences of 1-2 participants (Clandinin & Connelly, 2000; Creswell, 2013). However, this study recruited multiple students from four departments within the College of Engineering. This approach was taken for three reasons. First, by recruiting from nearly all the departments within the College of Engineering and creating a combined narrative, there is less chance of a loss of confidentiality of those participants. The insular nature of departments reflects a small community so the risk of a unique story being identified is much greater (Josselson, 2007). Second, a risk with Narrative Inquiry is that a participant may find their personal story filtered through a researcher narrative to be deeply unsettling. By aggregating the stories of the group, they may recognize elements of their personal story, but it becomes part of a larger whole to enhance transferability. Third, researchers have shown that departments are structured differently which may result in different socialization, sources of support, and challenges for these students (Devos et al., 2017; Gardner, 2010a; Gardner & Barnes, 2007; Girves & Wemmerus, 1988; Golde, 2005; Golde & Dore, 2001; Nettles & Millett, 2006). Seeking participants from multiple departments may lead to deeper insights and contextual information that may better inform an action.

Due to the diverse disciplinary culture of engineering, professional opportunities available to doctoral graduates, and increased competition for traditional academic careers across departments, it was expected that more differences than similarities will be found despite their responsibilities being similar. Thus, generalizations cannot be assumed for this study. However, the study will allow for transferability of information that can apply to a wider array of engineering doctoral students.

The following exclusion criteria were used in recruiting these students:

1. The participant must be a U.S. citizen or permanent resident. Temporary visa holders will not be considered for participation. International students comprise the majority of engineering students (NCSES, 2018). However, their enrollment has declined by 7.6% and 12.9% in engineering programs and computer science programs respectively from 2016 to 2017 after years of steady growth (Redden, 2018). Factors attributed to this decline (i.e., increased competitiveness from universities in other countries, increase in tuition and fees for international students in the United States, and the perception of the current United States political climate) (Gluckman, 2018; Redden, 2018; Wermund, 2018) are outside of the scope and attainable action of this study.
2. The participant must be a doctoral student or recent Ph.D. graduate within the College of Engineering.
3. Participants who have been within their doctoral programs for greater than six years will be excluded from this study. While average time to degree since a bachelor's degree is 7.3 years for engineering doctoral students (Nettles & Millett, 2006), six years was chosen as a maximum because more recent Council of Graduate Schools data shows that Ph.D. completion rates peak at six years for engineering students and steadily decline in subsequent years (Sowell, 2008). By excluding doctoral students who take longer than six years to graduate, participant experiences will be more aligned with the framework of Doctoral Student

Development such as actively seeking employment while conducting dissertation research (Gardner, 2009).

This study focused on the career paths and resources for domestic students because the researcher is a domestic student and has a better understanding of the factors involved in pursuing a career within the United States as a citizen. International students face a variety of additional considerations and challenges (e.g. immigration visas and current political climate) when pursuing a career especially if they wish to remain in the United States. While this study specifically focused on the needs of domestic engineering doctoral students, international students may also be able to benefit from the compiled resources as they will also need to develop transferable skills for their desired occupations.

Purposeful sampling was used to recruit doctoral students (Creswell, 2013; Glesne, 2006), but was flexible based on research constraints (Marshall & Rossmann, 2010; Miles & Huberman, 1994). This study strived for two participants from each engineering department, however some departments had such a small population of domestic doctoral students that they were unable to be recruited. Previous work with science and engineering graduate students (Gelles et al., 2018) has suggested that engineering graduate students are difficult to recruit, and some departments have a smaller pool of doctoral students that are eligible for this study. Convenience and snowball sampling were used to supplement purposeful sampling (Creswell, 2013; Miles & Huberman, 1994). For example, recruitment announcements were made during departmental seminars to recruit more participants. Additionally, because career options are still diverse within individual disciplines, two or more participants within the same discipline were recruited to represent diverse career interests.

3.3.2 Staff Participants

Various levels of Staff participation in this study were allowed. Staff participated from a variety of offices and departments. One staff member allowed a formal recorded interview, two staff allowed informal unrecorded and unstructured conversations, one staff member provided information via email, and all of the GPCs from the College of Engineering were asked if they were willing to disseminate career resources. Staff participants were approached for recruitment due to their involvement within offices that offer career services or have professional responsibilities towards graduate students at Utah State University. Varying levels of engagement in the Action Research occurred, which was dependent on the level of previous rapport already engendered with the staff members. Staff from Career Services and the School of Graduate Studies were intentionally approached because research has shown that Graduate Schools provide the most professional development programs and funding for professional development programs for STEM graduate students compared to departments or external grants (Denecke et al., 2017). Career Services is also an important partner involved in graduate student professional development which provides key services through non-departmental means such as career counseling and advising, programming (e.g. interviewing workshops), and placement services (e.g. career fairs) (Lehker & Furlong, 2006).

Flexible levels of participation were offered to account for the individual’s role, time, and preference to participate in the Action Research. The minimum level of participation in this study involved identifying relevant career resources. Additional ways to participate involved participating in an interview session, disseminating a pooled list of resources to graduate students generated through this inquiry, and becoming actively involved in the analysis and interpretation.

The following exclusion criteria were used in recruiting these staff participants:

1. The staff member must be currently employed during the data collection period of this study. In order to engage in Action Research, staff members must be currently in a position to understand and affect the current context.
2. The staff member must have been in their role for greater than 1 year. New professionals in Student Affairs positions have been "agents of change and innovation" because they are often similar in age and experience to the students they help (Barr & Sandeen, 2016, p. 639). However, professionals with less than a year of experience likely do not have the social or institutional capital and know-how to elucidate the contextual intricacies of their practice and to advocate for or enact a change.

Convenience sampling and snowball sampling were utilized for staff participants because there are only a limited number of staff employed within these offices (Creswell, 2013; Patton, 2002). The participant population pool was expanded to departmental staff within the College of Engineering (e.g. GPCs) and the Library.

3.5 Methodology

A combination of Action Research and Narrative Inquiry methodologies that involved collecting the narratives of engineering doctoral students through semi-structured interviews, and flexible collaboration with university staff that involved identifying career resources and the option to participate in a semi-structured data collection session (i.e., individual interview) was employed. Thematic analysis of doctoral student interviews was conducted to generate themes. This thematic analysis was followed by discourse analysis that considered both doctoral student and staff data. This analysis culminated in a researcher-constructed narrative incorporating the thematic and discursive results of the analysis set in the frameworks of doctoral student development (Gardner, 2009) and Fit Theory (Baker & Pifer, 2015) and a compilation of graduate student specific resources that was disseminated to the engineering doctoral participants in this study. Additional demonstrable action, after approval is granted, will be dissemination of the career resources by GPCs.

The two qualitative research methodologies and work that has been done within engineering education or with doctoral students specifically will be discussed in the following sections. Lastly, a description of how Narrative Inquiry and Action Research can be combined due to their similar focus on highlighting participants' voices and collaborative aspects will be provided in the last section. Through this analysis, this work is situated as a unique contribution to the field of engineering education and research on doctoral students. Figure 3-1 provides a visual summary of the research methodology which will be discussed in depth in the following sections.

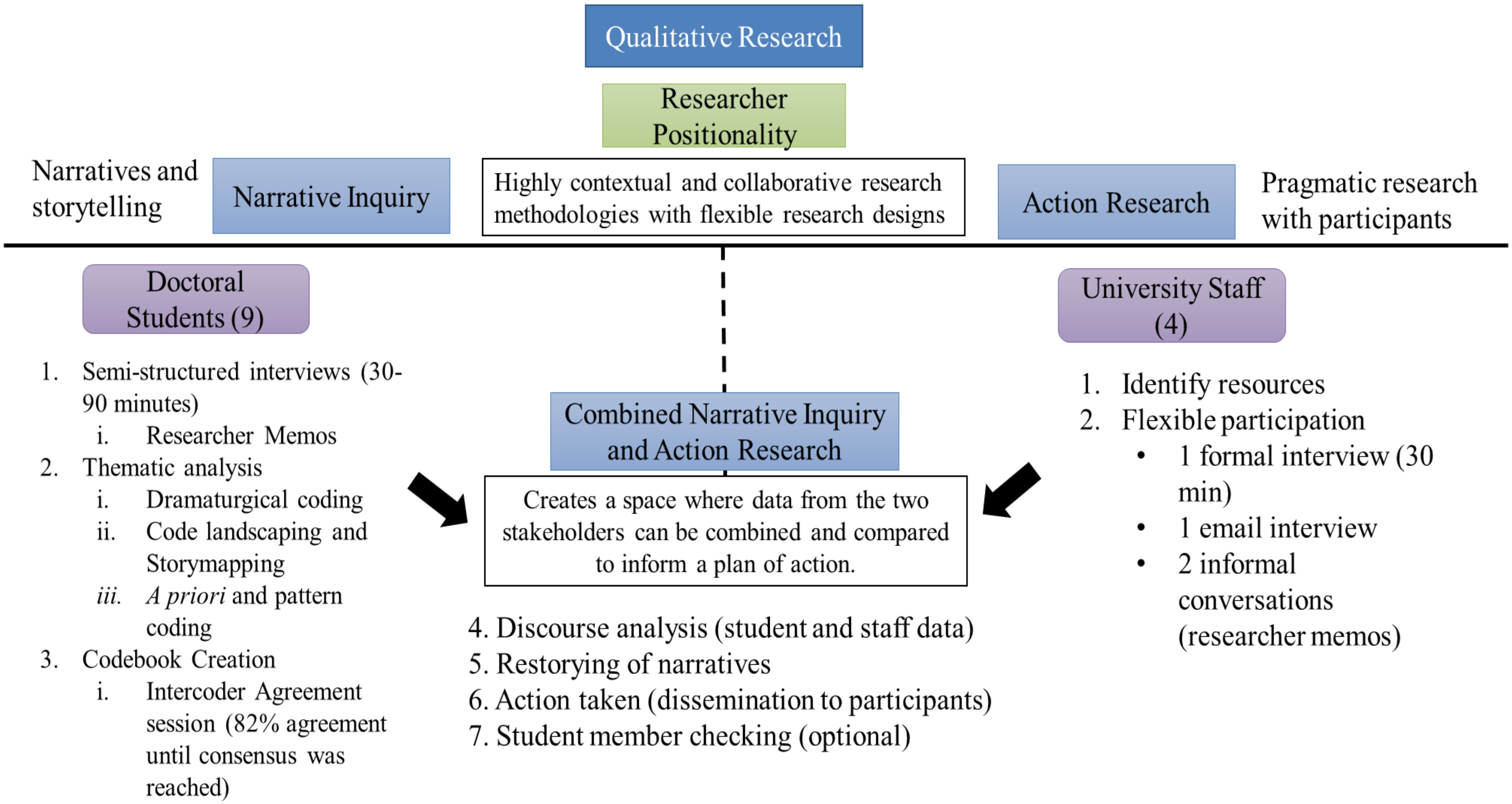


Figure 3-1. Research methodology summary.

3.5.1 Narrative Inquiry

Narrative inquiry is a qualitative research methodology that employs the use of narratives and storytelling to analyze and bring meaning to the experiences of individuals (Clandinin & Connelly, 2000; Creswell, 2013). Narratives are “stories people tell about their lives” which are a way to make sense of life (Bochner, 1994, p. 30). These narratives can be spoken or written to describe an event or a chronological series of events (Czarniawska, 2004). The central features of Narrative Inquiry are story living, telling, retelling, and reliving (Pushor & Clandinin, 2009). Additional important features of this methodology are gathering ‘stories’ of others through different forms of data (e.g. interviews, documents), an in-depth focus on the experiences of others, the emergence of a story from the collaboration between researcher and participants, the researcher shaping stories into a chronological account, and flexibility in the research design (Creswell, 2013). Because narrative stories occur within specific places or situations, the research is highly contextual and contains a temporal aspect where participants may talk about past, present, or the future (Clandinin & Connelly, 2000). This temporal component is important for studying the intended career paths of engineering doctoral students through the frame of doctoral student development because that career path may have changed since their entrance into a doctoral program. By using Narrative Inquiry, past and present can be explored concurrently to better understand their intended futures (Chandler & Torbert, 2003).

3.5.2 Narrative Inquiry and Engineering Education

Narrative inquiry has been identified as an emerging methodology within Engineering Education which can help researchers understand how students experience their educational context (Case & Light, 2011). Within Engineering Education, Narrative Inquiry has been used to study the experience of engineering undergraduate students (Marshall & Case, 2010; Meyer & Marx, 2014; Walker, 2001), faculty (Trellinger & Jesiek, 2017), teachers who led STEM focused informal educational programs for blind students (Villanueva & Di Stefano, 2017), non-traditional students (Minichiello, 2016), and graduate students (Lahenius & Martinsuo, 2011; Walker, 2001). In Lahenius & Martinsuo's study of 25 doctoral students within industrial engineering and management program at a Finnish university, they used a narrative analysis approach to increase understanding of the individualized study processes to determine what factors promoted or delayed their progress (Lahenius & Martinsuo, 2011). In Walker's study of undergraduate, masters, and post-doctoral students within a Scottish university, Walker focused on the construction of feminine and masculine identities using Narrative Inquiry within the department of electrical engineering (Walker, 2001). Walker noted that graduate students focused on their future career prospects and how traditional gender roles dominated their perceptions (Walker, 2001).

3.5.3 Narrative Inquiry and Doctoral Students

Narrative inquiry has been used to study the experiences of doctoral students both in the United States and internationally and is an ideal match for studying doctoral students because of their disparate and highly contextual experiences. Narrative inquiry studies on doctoral students have predominantly focused on identity development (Cotterall, 2015; Coryell, Wagner, Clark, & Stuessy, 2013; Schulze, 2015; Ye & Edwards, 2017), but other studies include explaining study processes (Lahenius & Martinsuo, 2011), coping strategies for the challenges of doctoral education (Devonport

& Lane, 2014), and the experiences of the doctoral journey (Bendix-Petersen, 2014; Keefer, 2015). Another study of doctoral students did not employ Narrative Inquiry as a research methodology, but instead studied doctoral students who chose unconventional research methodologies and writing styles such as those employed within Narrative Inquiry (Casanave, 2010). While none of these studies explicitly used development as a framework to understand the experiences of doctoral students, Narrative Inquiry has been studied through a human development perspective (Daiute & Lightfoot, 2004). This study would add to the growing body of literature utilizing Narrative Inquiry and doctoral students as participants through the unique frameworks of doctoral student development and Fit Theory.

3.5.4 Action Research

Action research is a participatory, democratic process that supports developing practical ways of knowing, which seeks to bring together action with reflection, and theory with practice (Carr & Kemmis, 1986; Reason & Bradbury, 2001). Action Research intentionally strives to cultivate change "within everyday, natural contexts rather than within controlled settings" (Cousin, 2009, p. 150) with the intended result being a "strategic improvement of practice" (Case & Light, 2011, p. 196). It is knowledge creation within context that requires researchers to work with stakeholders to generate knowledge and empower those who have a stake in the problem (Bradbury-Huang, 2010; Herr & Anderson, 2015). Action research has emerged from a broad range of fields and initially focused on collaborative research with stakeholders to promote democratic social change (Brydon-Miller, Greenwood, & Maguire, 2003). While Action Research intentions, practices, and traditions can be disparate, this methodology emphasized that knowledge is socially constructed and embedded within a system of values. Action research challenges the notion that credible knowledge must be objective and value-free (Brydon-Miller et al., 2003; Herr & Anderson, 2015). Action researchers who value and respect people's knowledge and ways of knowing have a unique ability to understand and address the issues that affect their environments and daily lives (Brydon-Miller et al., 2003).

While this collaborative research is intended to result in a change to the participants, it also brings transformative personal changes to the researcher (Brydon-Miller et al., 2003). What distinguishes Action Research from other forms of inquiry is the epistemological belief that the social world can only be understood by trying to change it (Brydon-Miller et al., 2003). Like other forms of qualitative inquiry, Action Research is contextualized, but Action Research distinguishes itself by being research *with* practitioners that always includes them as partners in the work of knowledge creation (Bradbury-Huang, 2010; Herr & Anderson, 2015). The key aspects of Action Research are working and being engaged with partners in context, an orientation towards taking action, reflexivity, and the significance of its impacts (Bradbury-Huang, 2010). The quality of an Action Research study is guided by practitioners' concerns for practicality, is inclusive of their way of knowing, and helps to build capacity for ongoing change efforts (Bradbury-Huang, 2010). Action research is founded on the belief that professional knowledge (e.g. research methods and experience) is important but local knowledge of the problem at hand is the key ingredient to research. Both these types of knowledge are essential to the Action Research process.

3.5.5 Action Research in Engineering Education

Action research is an emerging methodology within the field of Engineering Education (Case & Light, 2011; Daniels et al., 2015; Dele-Ajayi, Shimwell, Emembolu, Strachan, & Peers, 2018; Hoegh & Pawley, 2010; Howard & Toft, 2009; Jensen, 2016; Jørgensen & Kofoed, 2007; Mejía, López, & Molina, 2007; Riley, 2008; Solberg, 2018). It can be an effective methodology if the researcher wishes to not only systematically research their own practice but also implement “substantial personal and social change in their practice” (Case & Light, 2011, p. 197). Engineering Education researchers have predominantly used Action Research with elementary students (Dele-Ajayi et al., 2018; Solberg, 2018) and undergraduate students (Daniels et al., 2015; Howard & Toft, 2009; Jensen, 2016). Less common examples of Action Research include faculty (Hoegh & Pawley, 2010) and Revolutionizing Engineering & Computer Science Departments (RED) grants (Margherio, Doten-Snitker, Williams, Litzler, & Ingram, 2018). Notable and well-recognized examples within Engineering Education have used Action Research to create collaborative engineering environments (Mejía et al., 2007), to study the implementation of information systems (Hartmann, Fischer, & Haymaker, 2009), and to support the development of continuous innovation and innovation capabilities in freshmen engineering students (Jørgensen & Kofoed, 2007).

3.5.6 Action Research with Doctoral or Graduate Students

Compounding on the relative scarcity of Action Research studies in engineering education, the majority of literature that involves an Action Research methodology and graduate students is typically centered around how and why doctoral students (predominantly Ed.D.) incorporate Action Research into their dissertations (Klocker, 2012; Pilkington, 2009; Wetzel & Ewbank, 2013; Zambo, 2014) and how to improve professional skills or promote professional development (Amon, 2017; Greer, Cathcart, & Neale, 2016). Action research is rarely utilized as a methodology for Ph.D. dissertations. Researchers have questioned if the structured requirements and metrics for success for a dissertation are incompatible or too cumbersome for the completion of a dissertation, which is conceptualized as an independent individual activity within a fixed time frame and with measurable outcomes (Maguire, 1993; McCormack, 2004b; Moore, 2004). Despite this, doctoral students have successfully defended their dissertations utilizing an Action Research methodology given the limited time frame and structured university requirements by using a more pragmatic approach (Herr & Anderson, 2015). In these types of Action Research studies, the participants are involved in at least some phases of the research and the “participants’ understandings are deepened, or they are moved to action” (Herr & Anderson, 2015, p. 112).

Action research dissertations have been successfully completed at Utah State University. In a comprehensive search of electronic graduate theses and dissertations at Utah State University, three dissertations were found to have used Action Research as an explicit methodology (Draper, 2011; Ray, 2011; Welte, 2011). These three dissertations were in the field of Education with two being in the school of Teacher Education and Leadership with only one of these dissertations corresponding to a Ph.D. rather than an Ed.D. Action research methodologies are becoming more accepted for Ed.D. dissertations (Klocker, 2012; Wetzel & Ewbank, 2013), but they are lacking within the field of Engineering Education. This study would expand the field of Engineering Education by using an emergent methodology that would serve as an example for other doctoral students who are interested in how change can be made.

3.5.7 Action Research with Engineering Graduate Students

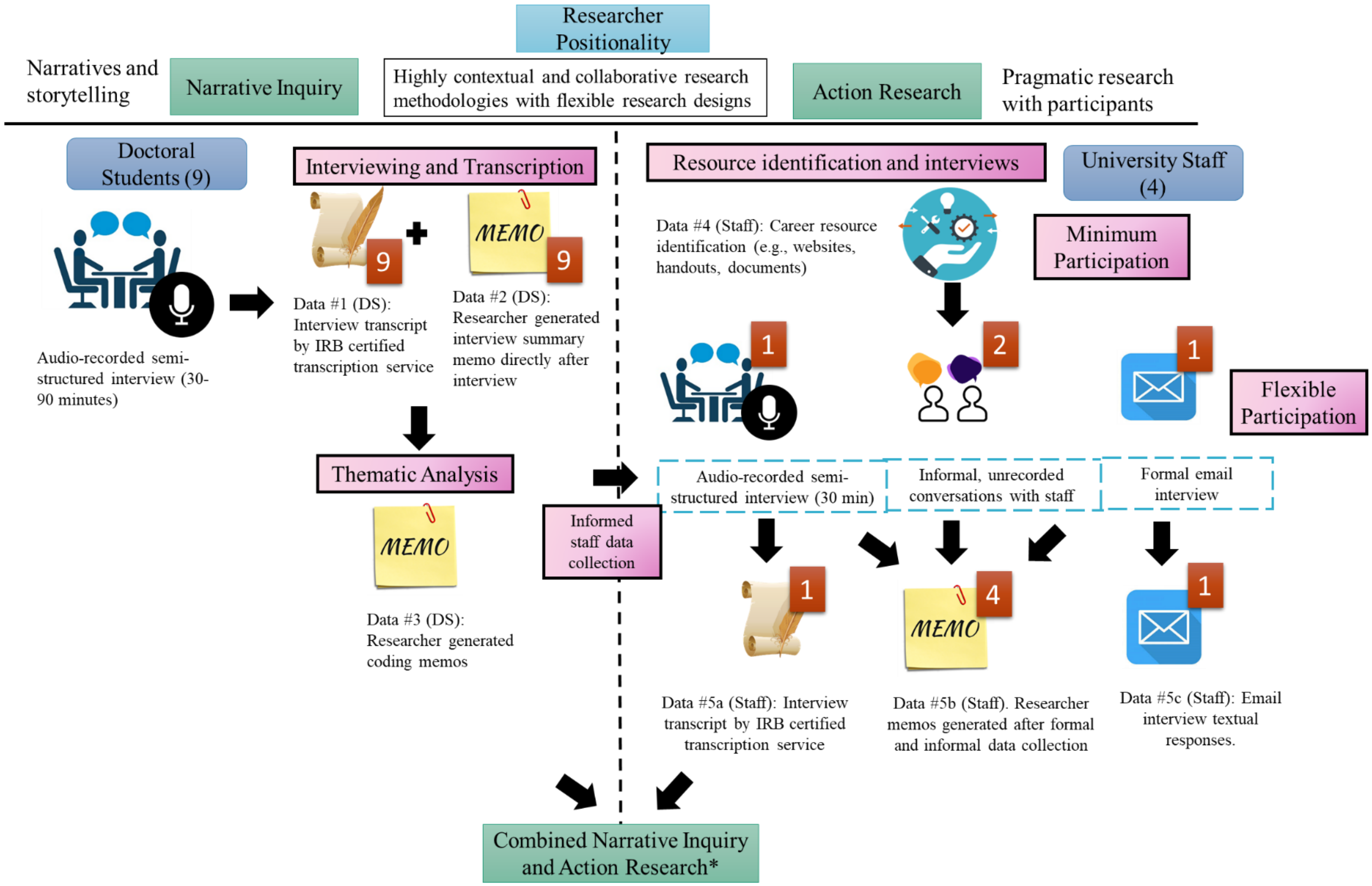
A search of several databases and journals relevant to the field (i.e., Scopus, Education Source, ASEE PEER, Journal of Engineering Education, International Journal of Engineering Education) yielded only three studies that use an Action Research as a method with graduate student participants. In one study, the researchers utilized a participatory Action Research (PAR) method to examine the career narratives of 46 women graduate students or postdoctoral fellows in STEM (Amon, 2017). However, the researchers specified using a grounded theory approach rather than an Action Research methodology and the authors noted that “participants did not play a significant role as decision-makers in the research project” (Amon, 2017, p. 8). The second study involved Master of Engineering and Master of Project Management students in Australia taking a professional development course designed to help students develop professional skills such as communication and ethical reasoning (Mann & Radcliffe, 2005). While the authors state they are using an Action Research approach, they focus more on action learning rather than the established qualitative research methodology of Action Research. The third study described how a course on teaching research skills course for engineering master’s students in Australia was improved through pedagogical approaches and collaborative efforts (Ferris, Sitnikova, & Duff, 2010). The authors did not explicitly name Action Research as a methodology, but they described a collaborative and practical effort with faculty, the authors, learning advisors, and library faculty for a strategic improvement of practice (Ferris et al., 2010).

3.5.8 Narrative Inquiry and Action Research

A critical differentiation between Action Research and Narrative Inquiry compared with other research methodologies is their enhanced ability to give voice to the stakeholders involved. Narrative inquiry has been paired with Action Research within educational research to allow for practitioners to “tell their stories of how they have taken action to improve their situations by improving their learning” (McNiff, 2007). This research brings together two perspectives: one where the researcher is an insider (i.e. engineering doctoral student) and the other who serve as active stakeholders of the context they are situated in (i.e. university staff). Through narratives and the collaborative relationships formed with the staff, the researcher will act as a bridge of both perspectives. Pushor and Clandinin argue that the interrelationship between Action Research and Narrative Inquiry is that the research “results in action or change in the practices of individual researchers, participants, and institutional practices” (Pushor & Clandinin, 2009, p. 290). By inquiring into stories that are lived and told, a gap is created which allows for change to occur (Pushor & Clandinin, 2009). This is where Action Research can complement Narrative Inquiry. Narrative inquiry can affect and change the practices and identities of researchers and participants through the retelling and reliving of stories (Pushor & Clandinin, 2009). As these changes are enacted in the people, so too are the landscapes in which they are situated able to change (Pushor & Clandinin, 2009). In this way, by first analyzing the experience and stories of the doctoral student participants, the retelling of these experiences to the Action Research stakeholders (i.e. staff) will hopefully create an active site that catalyzes change. Subsequently, by engaging stakeholders in a collaborative and flexible dialog, the researcher is uniquely positioned to advocate for an incremental and sustainable change. While sustainable change cannot be guaranteed and will not be measured, the products generated through this dissertation include an accessible compilation of career resources for graduate students that could be linked to an individual department's webpages or shared among graduate students.

3.6 Data Collection

Institutional Review Board (IRB) approval was granted to ensure the ethical treatment of human participants during the research. Data was collected from both student and staff groups of participants. These data collection approaches happened concurrently but also informed each other. Staff and students were approached and recruited at the same time. Formal data collection of student narratives and career resources occurred concurrently. Upon initial analysis of student narrative data and identification of career resources, semi-structured interviews for interested staff participants was conducted. One staff participant agreed to be recorded while the others contributed in informal ways. Figures 3-2 and 3-3 provides a summary of all data collection, triangulation, and research product generation activities for the individual and synthesized Narrative Inquiry and Action Research activities. Further descriptions of these activities are provided in Table B-1 in Appendix B.



Note. Expanded in Figure 3-3.

Figure 3-2. Data collection, triangulation, and research product generation activities for individual methodologies.

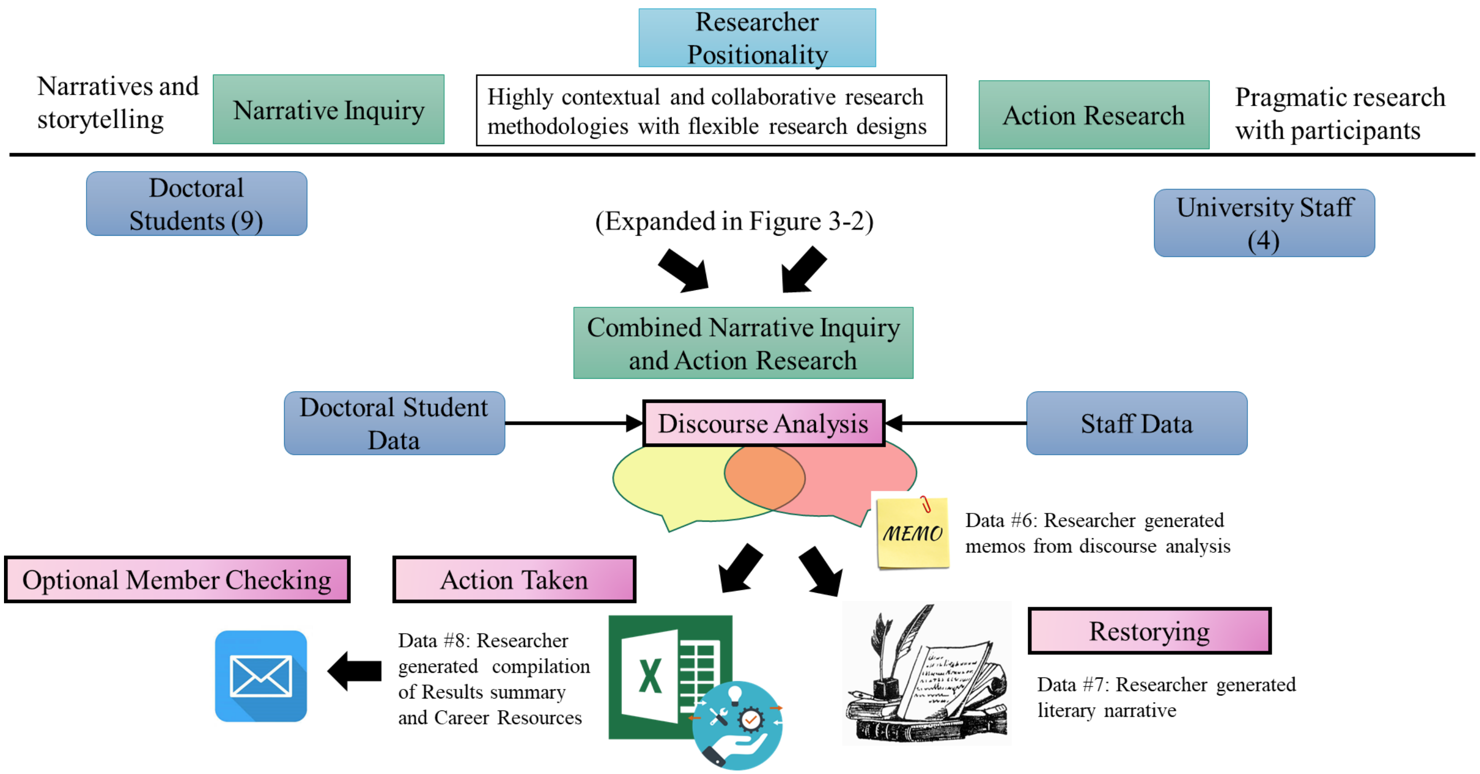


Figure 3-3. Data collection, triangulation, and research product generation activities for combined methodologies.

3.6.1 Student Participants

Doctoral student participants were recruited from the four departments within the College of Engineering (i.e., Civil Engineering, Environmental Engineering, Engineering Education, Mechanical & Aerospace Engineering). Student participants engaged in a short orientation session (15-30 minutes), a semi-structured interview ranging from 30 to 90 minutes depending on the participant, and an optional follow up member-checking through email (Creswell, 2013; Johnson, 1997). The orientation session was used to explain the protocols and procedures of the study and acted as a way for the researcher to develop trust and rapport with the participant (Creswell, 2013; McGinn, 2008). The goal of developing trust is to have the participant see the researcher as a real person invested in their success rather than a detached evaluator (McGinn, 2008). The researcher encouraged questions and reminded the participant of the voluntary nature of their participation. After orientation, the student participants were interviewed in-depth with the option to be audio-recorded. All student participants agreed to be recorded for their interviews. If the student participants had refused to be recorded, the researcher would have taken detailed notes during the interview. This interview contained questions about their intended career path, how that career path has evolved throughout the participant's academic career, perceived necessary career skills, and what resources they have utilized to pursue their intended career. At the culmination of this interview, the researcher wrote a detailed reflective memo of each interview.

Initial analysis of doctoral student data was conducted, which allowed the researcher to construct a narrative of the participants' aggregated experiences (Creswell, 2013; Hollingsworth & Dybdahl, 2007; McCormack, 2004a). Participants' data was member-checked through email, and they were allowed the opportunity to comment on the themes of the study and answer additional clarifying questions for triangulation purposes (Creswell, 2013; Johnson, 1997). Triangulation in qualitative research involves the use of multiple data sources or procedures including checking with the participants for verification and additional insight (Johnson, 1997). Member-checking allowed the participants the opportunity to comment on whether the data analysis reflected their experiences and to ensure their stories and voices were authentically captured into an aggregated narrative (Carlson, 2010; Josselson, 2007). Additionally, they were provided with the pooled list of career resources generated through this study.

3.6.2 Staff Participants

Staff participants who have experience within offices that offer career services or interact professionally with graduate students at Utah State University were recruited for this dissertation. The researcher first attempted to recruit staff from Career Services and the School of Graduate Studies. Informal, unrecorded conversations and email exchanges acted as a source of data. After analyzing the doctoral student interviews, additional staff from the Library and department were approached and recruited. Staff participation was flexible and allowed for informal and unplanned interactions typical of Action Research. This study was designed so that staff could participate in a way that was minimally intrusive of their time. This section will describe minimum participation required in this study and options for structured participation.

There were several levels of structured and unstructured participation depending on participant role, time, and preference. Their participation could involve (but was not limited to) one orientation session (15-30 minutes), identifying current career related resources, an interview (30-60 min), and disseminating a pooled list of combined career resources. The minimum requirement for participation in this study was the orientation session and providing a list of career resources.

The orientation session for staff participants was used to generate trust and rapport and to determine staff member interest and intended level of participation (Creswell, 2013; McGinn, 2008). These staff participants act as gatekeepers to their offices and the institution and will have a better understanding if the goals of the research are congruent with their office’s organizational mission. Therefore, building a relationship based on communication, mutual respect, and integrity can allow for a greater collaboration where both the researcher and the participants are useful to each other (Creswell, 2013; McGinn, 2008; Wills, 2016). Informal communication occurred beforehand to assess the potential participant’s interest in the research and the orientation session was initiated to attempt to align researcher and staff interest. After orientation, the participant was asked to identify any approved resources allowable for dissemination to students that could potentially help graduate students in their job search process, provide opportunities to develop transferable skills, and market themselves as viable candidates for hire. These resources represent collected data from the staff participant. They were also asked for a referral to other individuals that could potentially provide additional insight or resources.

Depending on the staff participant, they were allowed to participate in an individual semi-structured interview (30 minutes). The purpose of this interview was to gain a richer understanding of how staff participants help graduate students and to present them with a list of skills important to engineering doctoral students and possible resources they could provide (Appendix A). Data was collected and transcribed in the form of audio-recordings, researcher memos, and researcher notes.

Participants were encouraged to be an active part of the research process including design, analysis, and interpretation. However, limitations of time on both the researcher and staff prevented a continuous relationship to be formed with interested staff. Lastly, the final list of graduate-student specific pooled resources that were generated through this inquiry were disseminated to interested staff participants who could decide to further disseminate them to other graduate students in the future. This could be in the form of a listserv email and/or incorporating these resources in their websites so that a broader range of students can access them now and in the future. One staff participant has indicated their interest in incorporating these resources into an online guide they developed and maintained specific to student career resources.

3.7 Data Analysis

Formal qualitative data analysis focused primarily on the narratives of the doctoral students using thematic and discourse analysis (Creswell, 2013; Cheek, 2004; Gee, 2010). Thematic analysis was conducted using two cycles of coding. The first cycle of coding employed dramaturgical coding (Berg, 2001; Saldaña) which was followed by the transitional categorization methods of codemapping and storymapping (Saldaña, 2016), and a second cycle of coding. The second cycle of coding utilized *a priori* coding of engineering doctoral skills and job fit characteristics and pattern coding (Saldaña, 2016). A codebook was developed from the major categories through coding (DeCuir-Gunby, Marshall, & McCulloch., 2011) and an Intercoder Agreement (ICA) session (Bernard & Ryan, 2010; Saldaña, 2016) conducted with a peer within the department of

Engineering Education. This ICA session reached 82% agreement on the first coding cycle and was iterated until full consensus was reached. The codebook was updated to incorporate the feedback from the ICA. The final codebook is provided in Appendix C. Categories were further winnowed into the final themes presented in this dissertation.

Discourse analysis employed both student and staff participant data and immediately followed thematic analysis. Recorded transcripts were not available for all staff participants to accommodate flexible participation. This necessitated the reliance on researcher memos and other formal data collected for the staff aspect of discourse analysis. All researcher-interactions with staff participants resulted in researcher-generated reflection memos, which were used to inform the discourse analysis. Formal data collected (i.e. career resources, transcript from interview session, email interview) were transcribed and used in the discourse analysis. This culminated in a researcher-generated story through the process of restorying (Hollingsworth & Dybdahl, 2007; McCormack, 2004a). This generated story is an aggregate of the doctoral student participants' experiences that primarily uses the themes generated through the thematic analysis (Clandinin, 2007; Creswell, 2013) with insights generated from the discourse analysis. This narrative is provided in full in Appendix D. A summary of the major findings of this dissertation and a final compilation of internal and external career resources was developed and disseminated to all doctoral student participants and interested staff participants. These resources are provided in Appendix E. Participants were allowed to comment on the findings of the dissertation in a voluntary member checking session conducted over email. In this session they were asked three voluntary clarifying questions pertaining to the findings. Seven out of nine doctoral student participants participated in member-checking. A summary of the data analysis activities is provided in Figure 3-1.

3.7.1 Transcription

All recorded data was transcribed via an external and IRB-approved service provider, Speechpad, which provided a one-week turnaround on transcriptions. This researcher acknowledges that the process of transcribing involves analysis at some level (Psathas & Anderson, 1990). However, because discourse analysis is being employed, the content and context of the data is important (Cheek, 2004). The level of transcription should complement the level of analysis and thus, a more in-depth verbatim transcription was required for this study (McLellan, MacQueen, & Neidig, 2003). Transcription services provide a quick, accurate, and easy access to interview data. However, context and important clues can be lost within non-verbatim transcription. The researcher supplemented these transcriptions by listening and amending these transcriptions to ensure transcription consistency.

3.7.2 Thematic Analysis

Thematic analysis is a common qualitative analysis technique that examines and develops patterns of meaning within the data. Thematic analysis identifies implicit and explicit meanings in large data sets and results in winnowing of many individual codes into larger categories (i.e., themes) that reflect a more nuanced and summarized meaning than individual codes (Saldaña, 2016). This coding process is the critical link between data collection and the explanation of meaning (Charmaz, 2001). In Narrative Inquiry, data is analyzed by looking for themes that emerge from the "intertwining conversation" of the narrator and the listener and can include literary analysis of the narrative

(Hollingsworth & Dybdahl, 2007). Thematic analysis using dramaturgical coding was selected for the first cycle of coding to synergistically enhance the analysis (Saldaña, 2016). The first cycle of coding was followed by a transitional phase to categorize and make sense of the codes, creation of a codebook, and a second cycle of coding to further categorize and analyze the data. Figure 3-4 provides an overview of the thematic analysis process.

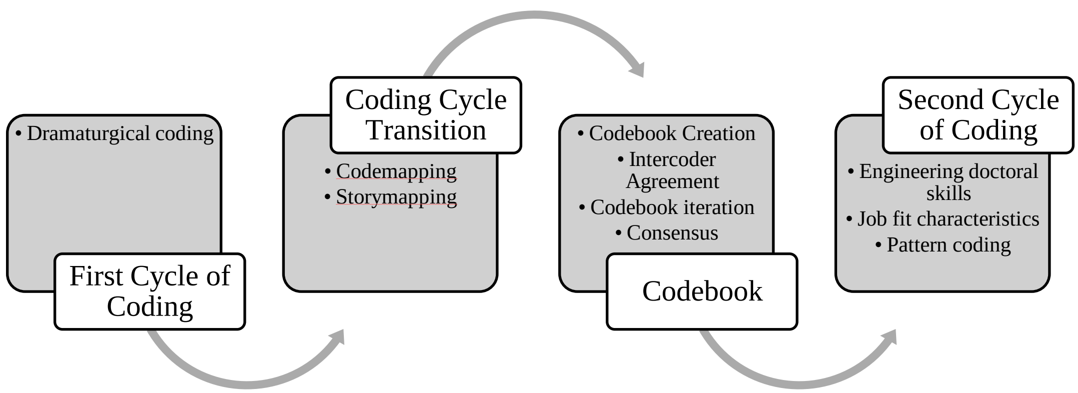


Figure 3-4. Thematic analysis process.

3.7.2.1 First Cycle Coding

Data was coded using MAXQDA 2018 (VERBI Software, 2017), a mixed-method analysis software. The first cycle of coding employed a combination of dramaturgical coding, which applies the “terms and conventions of character, play script, and production analysis to qualitative data” (Saldaña, 2016, p. 145) and emergent coding for participant described ‘job-fit’ characteristics (e.g., work-life balance). Dramaturgical coding included (1) characters; (2) objectives; (3) conflicts; (4) tactics; (5) attitudes; (6) emotions; and (7) subtext. This coding method involved elements of descriptive, emergent, process, emotion, values, and versus-coding, which the researcher has utilized previously (Gelles, 2018a; Gelles, 2018b; Gelles et al., 2018; Gelles, Villanueva, & Di Stefano, 2019; Gelles, Youmans, Villanueva, & Di Stefano, 2018;). Table 3-2 provides a description of these seven aspects of dramaturgical coding and what type of coding or analytical methods were used for each aspect. Dramaturgical coding was an optimal choice for a Narrative Inquiry methodology as it draws upon literary tradition and stories and explores interpersonal participant experiences resulting in a narrative presentational form (Saldaña, 2016).

Table 3-2. Summary of dramaturgical coding aspects.

Dramaturgical coding aspect	**Description***	**Coding or Analysis Method**	**Coding Example**
Characters	Other people mentioned by participants	Descriptive coding	Research advisor
Objectives	The participant's objectives and motives in the form of action verbs	Process coding	Complete Ph.D. quickly
Conflicts	Conflicts or obstacles confronted by the participant which prevent him or her from achieving his or her objectives	Versus coding	Short-term vs. long-term
Tactics	A participant's tactics or strategies to cope with conflicts or obstacles and to achieve his or her objectives	Emergent coding	Flexibility
Attitudes	Participant's attitudes towards the setting, others, and the conflict	Values coding, memoing	Ph.D. is all about research
Emotions	Emotions experienced or expressed by the participant	Emotion coding	Frustration
Subtext	The participant's unspoken thoughts or impressions	Emergent coding, memoing	Timing

*Note: Descriptions are adapted from Saldaña, 2016 pp. 145-146.

3.7.2.2. Coding Cycle Transition

Code mapping and storymapping were used as a transitional analysis between the first and second cycle of coding, which allows for reorganizing and reconfiguring of the codes (Saldaña, 2016). Code mapping is an iterative method that reorganizes and reconfigures data, which takes all the codes generated in the first cycle of coding and organizes them into categories with the intent to begin forming larger themes or concepts (Saldaña, 2016). Storymapping is a process that reconfigures extensive participant data into a single narrative often using pictographic or visual representations (McCormack, 2004a). After the first cycle of coding, codes from the seven aspects of dramaturgical coding were compiled and categorized to form seven larger categories to both winnow the codes into larger themes and to develop a coherent storyline using an aggregated account of the nine doctoral student participant narratives. The seven categories that emerged from codemapping are provided in the Codebook in Appendix C. Storymapping utilized dramaturgical coding to create literary elements necessary for a story (e.g., characters, plotline, conflict, antagonist). The theoretical framework of Doctoral Student Development (Gardner, 2009) was utilized during storymapping to create three main characters to represent the three phases of development. Figure B-1 in Appendix B provides an example of storymapping to develop the three main student characters of the constructed narrative.

3.7.2.3 Codebook and Intercoder Agreement

A codebook was developed after the first cycle of coding and coding cycle transition stages to formalize the operationalization of codes into larger categories (DeCuir-Gunby et al., 2011). This codebook was iteratively validated through an intercoder agreement (ICA) session with a peer within the department of Engineering Education. The other coder was provided with one participant's entire transcript, the codebook, and a set of coding rules to follow to streamline the intercoder agreement process. The two coders initially found 82% agreement between all codes, and discrepancies were discussed at length and the codebook was updated. Code definitions were iteratively edited until both coders reached full consensus. This codebook, coding rules, and an example of the ICA check on a segment of text is provided in Appendix C.

3.7.2.4 Second Cycle Coding

A combination of *a priori* and pattern coding were used to winnow the categories and codes into three themes (Saldaña, 2016). Figure 3-5 provides a summary of second cycle coding methods that were utilized in thematic analysis. First, *a priori* coding of the important skills for engineering doctoral recipients for all types of careers (see Table 2-1) was conducted to determine the relevant salience of doctoral skills to participants, which was assisted by frequency counts. Frequency counts can be used to evaluate relevance of a code or compare across participant groups (Creswell, 2013). Averaged code frequency counts and visual tools within MAXQDA 2018 were utilized in tandem to not overattribute significance of high coding counts from participants who have longer interview transcripts. MAXQDA's code matrix and code relations browser were used to provide a visual depiction of code frequency by participant and co-occurrence of codes. To determine which skills were salient by career function, the total number of skill codes were delineated by participants' preferred career function and then averaged by the number of participants with that preferred career function. A participant's preferred career function was determined by considering the interviews holistically. The skill code averages sorted by preferred career function were then rounded to the nearest whole number. This process was also repeated for job-fit characteristics.

Job fit characteristics were coded using a combination of *a priori* and emergent codes developed and iterated in the first cycle of coding and transition stage to align with the Person-Vocation fit framework (Baker & Pifer, 2015). A *priori* codes utilized the Individual Development Plan (IDP) framework for postdoctoral careers in scientific fields developed by the Federation of American Societies for Experimental Biology and the American Association for the Advancement of Science [AAAS] (Fuhrmann et al., 2011). This framework is provided for free to interested parties through myIDP, which is an interactive, web-based career-planning tool that helps users assess their skills and abilities and identify the skills they would need to advance their careers (Hobbin, Fuhrman, Lindstaedt, & Clifford, 2012). This tool requires the user to self-evaluate their skills, values, and interests, and myIDP will suggest potential careers that might be a good fit for the user based on their responses. In combination, these attributes (i.e., skills, values, and interests) help inform a potential job-fit. Job fit characteristics taken from myIDP were iteratively combined and recoded with emergent job fit characteristics resulting from participant data. After job fit characteristics were coded, frequency counts and visual tools were used to evaluate relevance of a code or compare across participant groups. To further compare across participant groups (e.g., preferred career function), job fit characteristic codes were averaged among relevant participant groups and rounded to the nearest whole number. These job fit characteristic codes are included in the codebook in Appendix C.

Lastly, pattern coding was used to further organize the codes and categories and by doing so attribute further meaning to that organization (Saldaña, 2016). Pattern coding occurs iteratively throughout the analysis process and is accompanied by frequent researcher memoing. Culmination of second cycle of coding resulted in the three themes and their corresponding categories presented in Figures 4-1, 4-2, and 4-3 in the next chapter.

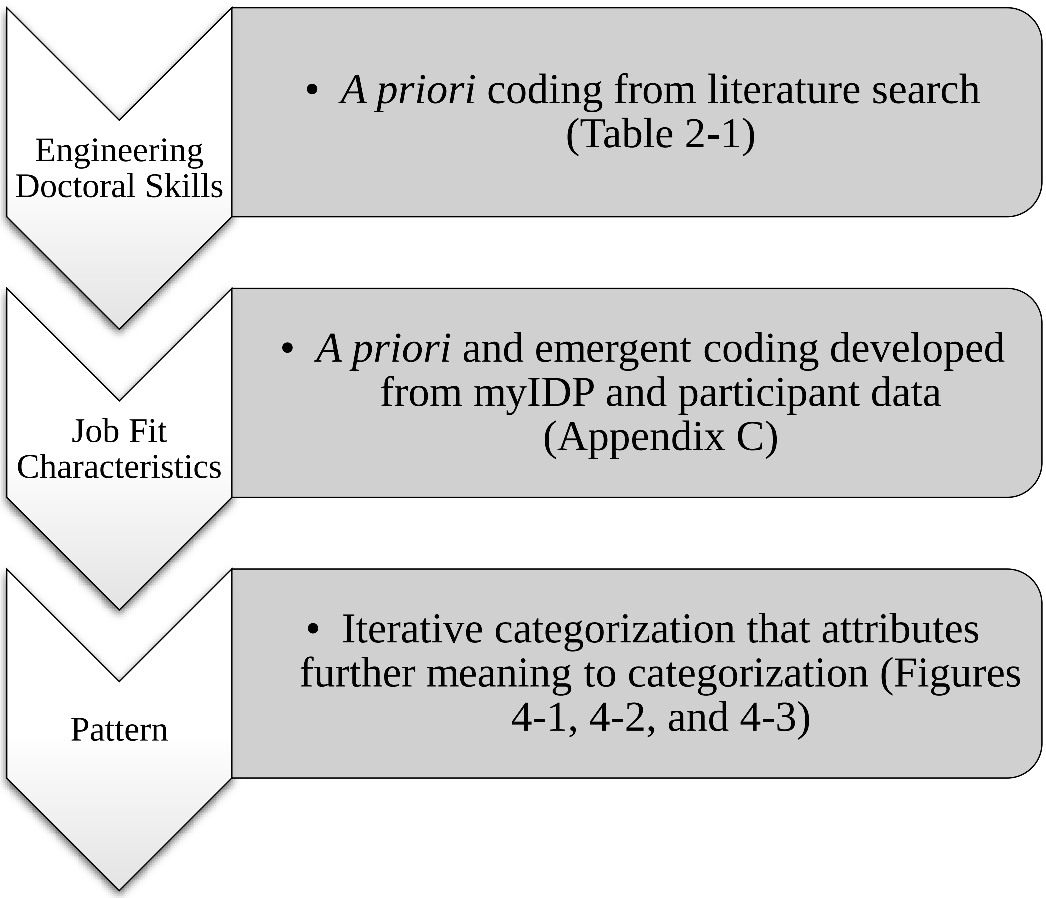


Figure 3-5. Second cycle coding techniques.

3.7.3 Discourse Analysis

Discourse analysis is an approach that is “concerned with how texts have been constructed in terms of their social and historical ‘situatedness’ ” (Cheek, 2004, p. 1144). It is a type of inquiry that assumes that language is not transparent or value free and that the spoken word does not have universal meaning but is assigned meaning by both speaker and listener in the context of the situation where the language is used. Discourse is always socially situated (Hicks, 1995). In the context of engineering education, discourse does not only apply to written text, but also to verbal exchanges, mathematical equations, graphs, and figures (Case & Light, 2011). Discourse analysis does not analyze the content of data but rather explains how things have come to be said or done, and what “has enabled and/or constrained what can be spoken or written in a particular context (Cheek, 2004, p. 1147). This is an approach that influences the research and researcher at all stages of the process (Hertz, 1996). This makes it an optimal analysis approach for Narrative Inquiry and Action Research, which require flexibility and collaboration.

Discourse analysis was employed after both doctoral student and staff data were collected to compare different accounts and opinions of the career resources on campus and how they were perceived and utilized (or not utilized) by engineering doctoral students and graduate students in general. The discourse analysis focused on any discrepancies between engineering doctoral student participant perceptions of career resources (e.g., Career Services) on campus and how staff participants perceived the value of those resources to graduate students. These engineering doctoral student and staff discourses were supported and informed by the results of the thematic analysis to clarify and interpret the discourse.

3.7.4 Restorying

The process of restorying participant data in Narrative Inquiry, allows for the researcher to reconstruct participants' data into a shorter, more linear, and compelling narrative (Creswell, 2013; McCormack, 2004a). After thematic and discourse analyses, the engineering doctoral student narratives derived from their interviews were aggregated and reconstituted into a three-part story with fictitious characters. This story combined both student perspectives and elements of the context they are situated within. Restorying followed McCormack's Process of Storying Stories (Hollingsworth & Dybdahl, 2007; McCormack, 2004a) and relied on the researcher's creative writing experience for stylistic considerations. The combination of dramaturgical coding and storymapping during thematic analysis acted as a framework for the construction of the narrative. Construction of a narrative focused specifically on the essential elements of constructing a story: (1) setting; (2) characters; (3) plot; (4) theme; and (5) conflict. The setting, character, and plot of the reconstructed narrative were amalgamated from engineering doctoral student participant and researcher experiences. The themes and conflict were created using thematic analysis; specifically, dramaturgical coding of conflicts. The story was constructed to encompass elements of the major themes from thematic analysis and incorporate aspects from the discourse analysis. The final constructed narrative is provided in Appendix D.

3.7.5 Member Checking

Member checking is a triangulation process in qualitative research where participants provide feedback on the aggregated results or themes to elicit the credibility of the interpretation (Creswell, 2013; Miles & Huberman, 1994). Member checking allows for participants to provide “critical observations or interpretations” about the analysis (Stake, 1995 p. 115). Doctoral student participants and actively involved Action Research staff participants were provided with the list of compiled career resources and a summary of the dissertation results. This summary and the compiled career resources are provided in Appendix E. Participants were then invited to comment on the results and provide feedback. Additionally, doctoral student participants were asked three specific questions pertaining to the major interpretations of the dissertation. These questions are provided in Appendix A.

3.8 Reliability and Validity

Action research does not make a claim of being context-free or value free (Herr & Anderson, 2015). Credibility, validity, and reliability are measured by the willingness of local stakeholders to act on the results of the research. Researchers have suggested that the validity of qualitative research, especially Action Research, resides in its authenticity (Carr & Kemmis, 1986). In this context, authenticity gives direct expression to the "genuine voice" of those whose lives are being described (Winter, 2002, p. 145). This requires adherence to several principles to present a narrative that adheres to the goals of Action Research while also fitting within the epistemological rigors of academic research (Herr & Anderson, 2015).

Heikkinen and colleagues describe five principles of validation in Action Research combined with narratives. These are (1) *historical continuity* (2*) reflexivity* (3) *dialectics* (4) *workability and ethics* (5) *evocativeness* (Heikkinen et al., 2012) and these will be described briefly below.

3.8.1 Historical Continuity

Historical continuity analyzes the past beyond the social present and acknowledges that "action does not begin in a vacuum, and action never ends" (Heikkinen et al., 2012, p. 8). This principle demands that the researcher delve deeply into the historical background of the topic and present events as a logical sequence. To ensure validity, this proposal has provided an extensive background of the structure and function of engineering doctoral programs, doctoral student development, career paths and skills, and Fit Theory. Through analyzing the narratives of doctoral students, a more in-depth understanding of the context of these students within the College of Engineering will be generated. Through informal (e.g. conversations) and formal (e.g. interviews) data gathering, a more complete picture of engineering doctoral students situated within the context of the university will be generated.

3.8.2 Reflexivity

The principle of reflexivity deals with how a researcher is aware of their way of knowing and of their positionality within the context of their study. It is “the extent to which the authors explicitly locate themselves as change agents” (Bradbury-Huang, 2010, p. 103). The researcher makes a conscious effort to understand the impact of their personal experiences when interacting with others in the Action Research and what presumptions about reality they bring to the study (Berger, 2015; Heikkinen et al., 2012). This principle is critical for both Action Research and Narrative Inquiry (Adams, 2008; Bradbury-Huang, 2010). A narrative of Action Research does not create the illusion of objective reality through observations and reports but rather explicitly acknowledges that the narrative is a construction (Winter, 2002). A reflexive researcher does not claim to describe a unified, objective reality, but takes the role of a subjective presenter of several disparate realities (Berger, 2015). This reflexivity requires frequent reflection on the part of the researcher and adherence to transparency in all research activities (Berger, 2015; Claris & Riley, 2012; Heikkinen et al., 2012).

This study will adhere to the principle of reflexivity by acknowledging the researcher’s relative role and biases (i.e. positionality) within this research and to engage in a continuous process of memoing through all stages of the research (Saldaña, 2016). Memoing is a critical part of qualitative data analysis, which is roughly equivalent to a lab notebook in experimental research (Vogt et al., 2014). This helps a researcher keep track of the evolution of a study (Saldaña, 2016).

3.8.3 Dialectics

The third principle is the principle of dialectics which states that truth is constructed through interaction (Heikkinen et al., 2012). To address this third principle, the interpretive framework of dialectics was used to bring both student and institutional perspectives in a dialog. Dialectics are a dialog between two or more standpoints about a subject with the intention of establishing truth through reason (Greene & Hall, 2010). Dialectic stances assume that divergent or dissonant inquiry results are held with equal regard and analyzing these stances leads to new insights and perspectives. This stance recognizes that human phenomena are complex and better understanding comes from multiple perspectives and a dialectic approach seeks a greater understanding and acceptance of differences in order to ease the tensions that may divide people. It is a stance that requires critical reflection and seeks to make a positive social change. This principle reinforces the concept of authenticity through the voices of the participants (Heikkinen et al., 2012).

Addressing the principle of dialectics was achieved by approaching the study specifically through the interpretive framework of dialectics, designing the study so that data (e.g. narratives, interviews) was collected from both students and staff at multiple time points and informed by each other, and using discourse analysis as an analytical method. To accentuate the anticipated dialog in participant data sources, both groups of participants were initially approached concurrently, but formal data collection (i.e., interviews) of the staff participants was informed by the doctoral student interviews and member-checking of the students was informed by the perspective of both the staff and doctoral student participants. In this way, the researcher acts as a conduit of dialog between students and the interests and realities of the institutional offices.

3.8.4 Workability and Ethics

The fourth principle is the principle of workability and ethics. Workability means taking a pragmatic approach to the research which is common in Action Research (Herr & Anderson, 2015). A pragmatic approach is known for its epistemological and methodological flexibility that focuses on the outcomes of research and what works to solve problems (Biesta, 2010). Embedded in workability is an ethical attitude that is critical for Action Research (Heikkinen et al., 2012). This considers the practical consequences of research on the participants, the researcher, the scientific community, and society. When considering the ethics of Narrative Inquiry, it is important to understand that Narrative Inquiry is inherently a relational endeavor where interpersonal ethics are balanced with professional responsibility (Josselson, 2007). Adding to this, Adams (2008) states that, “working with ethics involves realizing that we do not know how others will respond to and/or interpret our work” (p. 179). Being unable to predict how a participant will respond or interpret the results emphasizes the need for researcher reflexivity and to carefully consider the study from the point of view of the participants.

Ethical considerations were embedded at all stages of the research including design, data collection, data analysis, and dissemination of results. This included taking measures to ensure confidentiality by seeking out multiple participants, giving the option to be audio-recorded, and aggregating results, not placing an undue time burden on participants by limiting data collection sessions to an hour or less, and offering flexible ways to participate such as optional formal in-person and email interviews. By providing flexible ways to participate, participants were able to contribute in a way that is more convenient, have agency in how they engaged in the study, and were able to pragmatically contribute to the research (Herr & Anderson, 2015). Researcher bias was mitigated by stating researcher positionality, using the interpretative framework of dialectics to give equal weight to doctoral student and staff perceptions of career resources, an intercoder agreement check, and member-checking. As part of institutional requirements, meeting this principle of ethics and regulation was enforced through Institutional Review Board approval (IRB).

3.8.5 Evocativeness

Lastly, the principle of evocativeness states that good research evokes emotions and mental images (Heikkinen et al., 2012). The reporting of this research should lead others to think about the issue in a new and different way and should impact or influence the reader on an emotional level. This principle acknowledges that “the most significant learning experiences are both cognitive and affective in nature” (Heikkinen et al., 2012, p. 10). While this work does not attempt nor claim to be wholly aesthetic, reporting the results drew upon the principles of storytelling which sought to draw a reaction from the reader. A dissertation was the final product of this research process. However, dissertations are lengthy, are often written in academic prose, and can assume that the reader understands the research traditions and paradigms embedded within. This can render the work inaccessible to larger audiences. To make this work both evocative and accessible, a shorter narrative written for a non-academic audience was created and provided in Appendix D.

CHAPTER 4

RESULTS

Nine engineering doctoral student interviews across four different engineering disciplines at Utah State University were contextually analyzed using thematic analysis. This analysis revealed the emergence of three main themes in the participant narratives. These three themes are (a) Engineering Doctoral Identity; (b) Engineering Doctoral Student Skill Development; and (c) Time, which are presented in section 4.1. After thematic analysis, the results of the discourse analysis between what was discovered through informal and formal staff interviews and data collection and the engineering doctoral student interviews are presented in section 4.2. This discourse analysis revealed the differing perceptions of the value and utility of career resources between engineering domestic doctoral students and university staff. Using storymapping and restorying (McCormack, 2004a), these themes and discourses were arranged into a narrative intended to present the results in a more accessible way. This narrative is provided in Appendix D.

4.1 Domestic Engineering Doctoral Student Thematic Analysis

Three themes emerged from the thematic analysis of the nine doctoral student interviews. These three themes are (a) Engineering Doctoral Identity; (b) Engineering Doctoral Student Skill Development; and (c) Time. Engineering Doctoral Identity is further broken down into two categories of identity: (i) Insider Definition; and (ii) Perceived Fit. These categories are further broken down into four subcategories which are described in Figure 4-1 below. The theme of Engineering Doctoral Skill Development was further categorized into: (i) Salient Engineering Doctoral Skills; (ii) Career Function

Skill Alignment; (iii) Restricted Skill Development; and (iv) Purposeful Skill Development, which are shown in Figure 4-2. The theme of Time was further categorized into three categories: (i) Objective Time; (ii) Subjective Time; and (iii) Time Adaptive Tactics, which are described in Figure 4-3.

4.1.1 Theme #1: Engineering Doctoral Identity

Throughout their interviews, doctoral student participants reflected on what it meant to pursue and attain a Ph.D. in their respective programs and within the field of engineering in general. While the individuals from four departments within the College of Engineering (i.e., Civil Engineering, Engineering Education, Environmental Engineering, Mechanical and Aerospace Engineering) expressed different experiences and contexts, their aggregate perspectives revealed a similar construction of an engineering doctoral identity. This identity evolved throughout their time within their program and was co-constructed along with and relative to the individuals in their departments (i.e., faculty and fellow doctoral students). At the same time, participants had to consider how to shape their identity relative to their intended career path and perceptions of what future employers would want from them. This engineering doctoral identity was predominantly defined by participants' interactions with 'insiders' or individuals who have a Ph.D. in their field. At the same time, participants internalized their experiences within their programs to inform their "fit" in their departments and with their future careers. When considering their fit with their future careers, they may also be considering the perspective of 'outsiders' or individuals who do not have a Ph.D. in their field.

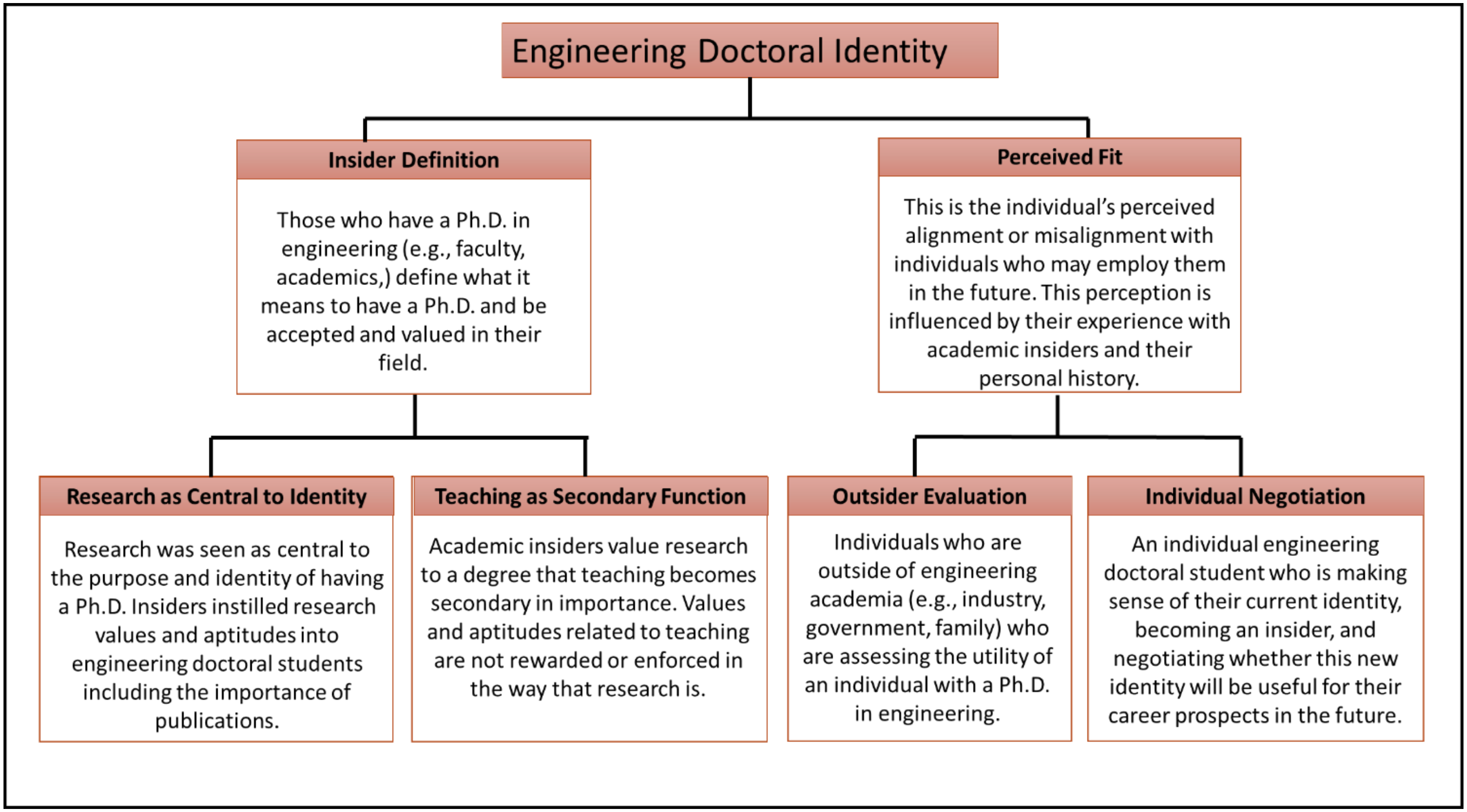


Figure 4-1. Engineering Doctoral Identity theme and its two minor categories and four subcategories.

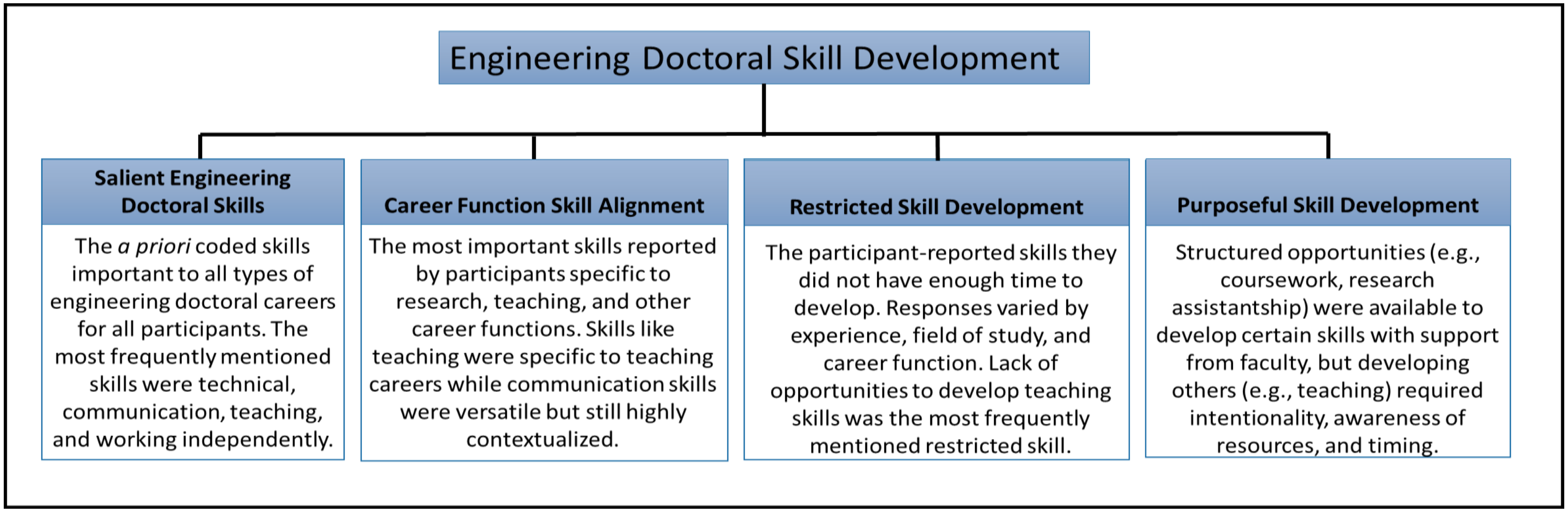


Figure 4-2. Engineering Doctoral Skill Development theme and its four minor categories.

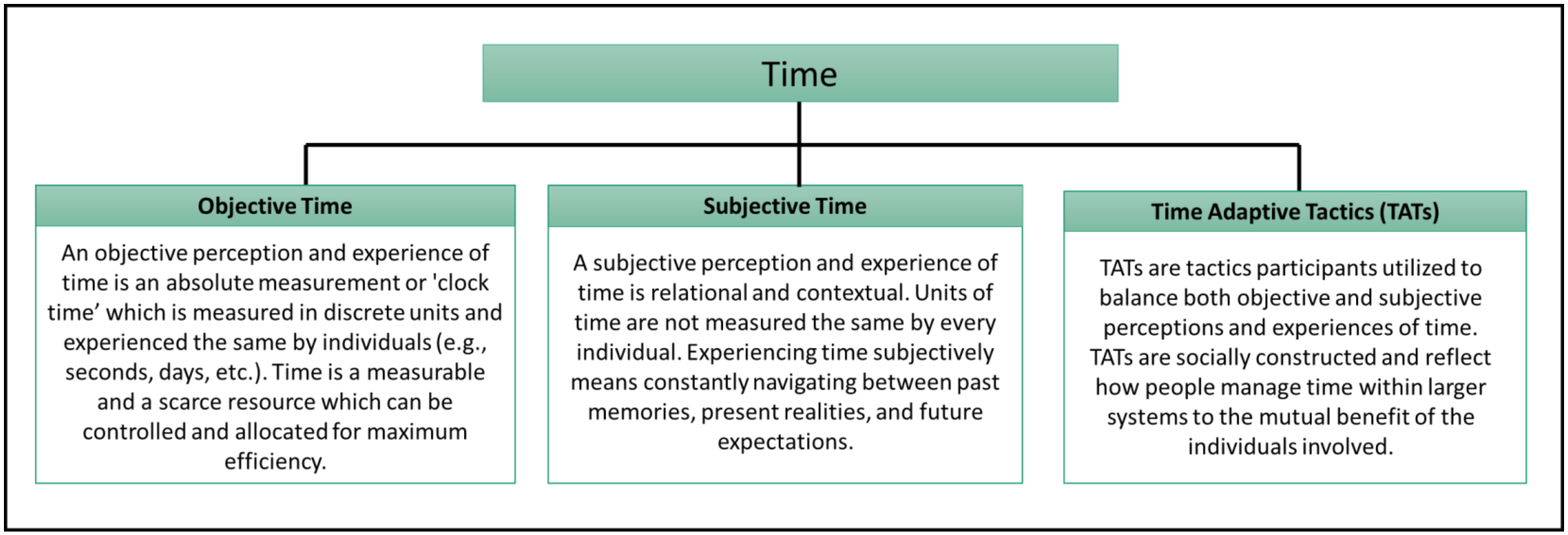


Figure 4-3. Time theme and its three minor categories.

Through this constant negotiation of engineering doctoral identity by insiders and outsiders, participants attempted to make sense of what insiders required of them, the perceived evaluation of utility from outsiders, and how that perception informs their alignment or misalignment with the qualifications and competencies of their intended future career path.

4.1.1.1 Insider Definition of Doctoral Identity

The development of participants' engineering doctoral identity was highly influenced by the individuals who already had a Ph.D. or were pursuing a Ph.D. within their programs. These individuals were coded as 'Insiders' because they define what it means to have a Ph.D. and be accepted and valued within the field. Insiders showed and enforced a value of research to participants, which came at the relative devaluing of other aspects such as teaching.

Research as Central to Identity

Across all engineering disciplines, participants identified research as being the most defining aspect of earning a Ph.D. in their field. Research, being central to doctoral identity, informed the values and aptitudes of that identity. Thus, traits and aptitudes associated with research (e.g., precision, technical competency, innovation) and metrics of proving research aptitude (e.g., publishing research) were embedded into the academic culture of research. This culture of research—reinforced through prestige and 'insider' status--informed how students were recruited and other aspects of their doctoral student experience.

Research Values and Aptitudes

Research was simultaneously seen as a job function, an aptitude, and the reason to pursue a Ph.D. in engineering. For example, one participant stated:

> *The purpose of a Ph.D. is to introduce the student to research, to help the student learn how to do research, how to recognize good research, and to get your foot in the door basically with expanding the field, which is involved through research, essentially*. (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 26).

In fact, when asked what the purpose of a Ph.D. in engineering was, all nine participants mentioned research in their responses with eight explicitly stating that research was the purpose and the ninth focused on being a leader and expert in the field. The participants' focus on research as central to their doctoral identity was also revealed through what aptitudes, attitudes, and activities were valued within their programs. These research-focused values and aptitudes were important in both what participants had learned in their program and what they needed for their future careers. When asked what skills were important for their chosen career, a Ph.D. candidate responded,

> *Developing research questions or hypothesis, figuring out...Really, I guess even before that, figuring out what is a problem in my field and is there even a way to research it or try to solve it or fix it? What could a research problem or research proposal look like around that problem? Research methods, data collection methods, I mean, everything that goes with research I feel like is a very important skill set in my field.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 92-93).

All participants brought up at least one aptitude necessary for conducting research (see Table 2-1) with seven out of nine describing highly technical research methods or techniques and all nine naming aptitudes conducive to research such as working independently and critical and analytical thinking. Beyond naming specific technical skills associated with their research, participants frequently mentioned how engineering Ph.D.s were precise, thorough, and innovative. Participants described Ph.D.s as pushing boundaries through their research and being an expert in a topic area. When comparing engineers with Ph.D.s to engineers with bachelor's degrees, participants reflected that engineers with Ph.D.s were required to have the same breadth of engineering knowledge with an additional depth of their specific expertise that came from their research that engineers with bachelor's. degrees did not have. In contrast, participants described job functions (outside of research) performed by engineers with a bachelor's degree as a terminal degree as routine and strictly following instructions to achieve an expected outcome. For example, a recent graduate stated:

> *A bachelor's degree knows when to quit. The main fundamental difference is that an individual who's decided that they're willing to spend five, eight years of their life getting, you know, a master's and Ph.D. or Ph.D. from bachelor's is the ability to produce unique research questions and to answer them as opposed to, I'd say in a bachelor's setting, the point of that is to be able to apply known solutions to new problems. Those with the Ph.D., the idea is to apply or develop unknown solutions to new problems. And I'd say, the training in a Ph.D. program gives individuals tools to do that*. (DS #5, Recent Graduate, Service focused career [Academia], Line 32).

Participants described how insiders such as faculty perpetuated this message that engineers with bachelor's degrees performed routine work compared to engineers with Ph.D.s. One participant stated that when asking for career advice from a professor in their department, the professor explained what types of jobs were available for the various degrees. The participant reiterated this career advice by saying:

> *Just giving advice on what types of jobs kinda, in general, are out there for different degrees. So, a bachelor's degree might be more just mundane, routine work, doing the same thing over and over again, just applying it differently. And design work would be maybe for the higher degrees. So, advice like that and then maybe just advice as to try to find what kinda career would best suit me type of thing.* (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 99).

This perspective that engineers with bachelor's degrees performed more routine work compared to engineers with Ph.D.s was prevalent even though the majority of participants in this study have a bachelor's degree in engineering and described the process of attaining that degree as difficult.

<u>Metrics of Research Success</u>

Participants were well-aware that research in academia must be documented. The written products of research were emphasized over all other tangible evidence of their experience as a doctoral student including developing curriculum or practical applications of research. These written products included conference papers, journal manuscripts, or a dissertation. When commenting on what were the most important skills for academia, a recent graduate focused on the importance of writing papers. They said:

> *Because [writing papers] is a significant portion of the metric of success in academia. I would argue that teaching should also be a major component of that analysis of the caliber of an academic, but it doesn't seem to be from the academics. I've spoken with everyone who I asked, "What should I get out of a postdoc?" No one says teaching experience, right? They all say, "Well, you need to get publications out." So, for at least the near term, the ability to write papers*

> *is, I think, the most valuable skill that I've gotten out of it. If I decide to go into the position in the private sector, say, which is not high on the list of likely candidates, I'd say that's kind of almost a wasted skill.* (DS #5, Recent Graduate, Service focused career [Academia], Line 95).

The dissertation in particular was important to the participants because it was a method of training them not only how to conduct research but also how to write academically. Another recent graduate focused on the dissertation process as a method of proving that they knew how to conduct research to other academics (i.e., insiders). They said:

> *The purpose of the dissertation is simply to show your committee that you know how to do research in the field. You understand what methods are appropriate, you understand how to state a problem and do the methodology to say here's the correct method to answer that question and how to collect the data and how to analyze it. And that is all you have to do. So, really, a dissertation is like a research paper.* (DS #3, Recent Graduate, Engineering focused career [Various], Line 67).

<u>Implicit Lessons within the Culture of Research</u>

Another aspect of how insiders define engineering doctoral identity focused on how implicit values and lessons were embedded into the academic research culture, which doctoral students began to internalize as part of the process of earning a Ph.D. One of these implicit lessons was the amplification of prestige or being preeminent over even other engineers. Participants believed that an individual with a Ph.D. in engineering had all of the technical skills and knowledge of an engineer with a bachelor's and often master's degree, but with additional leadership skills, creativity, and in-depth expertise on a subject. Participants indicated that earning a Ph.D. in engineering was indicative of an individual's intelligence, experience gained, and persistence. The majority of participants had a bachelor's degree in an engineering field (eight out of nine) and a master's degree (six out of nine) in an engineering field. Thus, participants viewed the greater prestige that came from earning a Ph.D. as compared to the prestige of earning a bachelor's or master's degree in engineering as a logical progression of attributing greater esteem to higher degrees. When describing engineers with Ph.D.s, one participant stated, "I think it's a very special breed of people who do Ph.D.s. It's a lot of schooling. We're very special individuals." (DS #8, Integration Phase, Research focused career [Various], Line 41). Participants also described how having a Ph.D. as a credential was equated with a level of trust and respect in that individual's intelligence and capability beyond what was attributed to an engineer without a Ph.D. One participant also described how they used to perceive faculty, prior to their pursuing of their doctoral degree, as being on a different intellectual level than anyone else or what was even personally achievable. Another participant mentioned how they were initially unaware that becoming a professor was an option for them. Before pursuing undergraduate study, they said that they wanted to be a teacher because they loved teaching but knew they could not comfortably support the large family they wanted on a teacher's salary, so they pursued a more lucrative career in engineering instead. When asked to clarify when they realized they could teach at the collegiate level, they stated:

> *I didn't think about that until my master's degree. It never occurred to me that all these [professors], they're just normal people. I saw professors who are like...I don't know. I don't know how a professor is made. I just knew they went to school for a long time and I thought, I'm not doing that. But here I am. So, but I don't*

> *know. It just never occurred to me that I could become a professor*. (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 52).

It was only when the participant began to gain an 'insider' status through seeking a higher degree that teaching at a professor's level became a realistic option for them. In this case, prestige manifested in a heightened value of insiders' (e.g., faculty) intelligence even in comparison to perceptions of engineers employed within other fields like industry.

Another implicit lesson centered around prestige was what was required and how to attain a postdoctoral career, especially if that career was in academia. Participants who were interested in research careers inside and outside of academia described how a Ph.D. was a pre-requisite for those careers. One participant stated, "If you wanna go into academia, it's a must, obviously. So, it opens up academia as a career option and it does open up some career possibilities in industry as well." (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 30). When talking about the type of research institution an academic-career seeking participant was interested in, they spoke of R1 and R2 institutions because:

> *[…] I think they have a lot of potential. They have a lot of potential just within their teaching, but not a lot of people are really interested in that, but you'd still need that Ph.D. credential to even get to that level.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 40).

While participants seeking academic careers acknowledged that there were other ways to work within a university (e.g., adjunct, lectureship) or even at other types of institutions of higher education (e.g., private), they expressed preference for research-intensive institutions with undergraduate engineering programs.

The importance of prestige also manifested in how participants approached their job search. Participants who intended to go into academic careers generally only trusted 'insiders' to have the ability to help them identify and pursue engineering careers past the Ph.D. All participants expressed that they had or could go to their research advisor or other faculty for career advice or support, while only two used Career Services as a graduate student. One participant described how having a parent who was a faculty member and growing up interacting with other faculty affected who they sought out for career advice:

> *So, I basically grew up in the physics department and so I'm really close with a lot of those professors and advisors there. And so I feel like when I want career advice or something, I go to a professor I know, or like an advisor I know because I have relationships with them already and I don't want to meet with a Career Services member who will give me the same paper that she gives every other student coming into her office. I guess I want something a little more personal and, I don't know, maybe I'm kind of lucky that I have that structure built into my life already because I know a lot of students don't, especially ones who come from different universities. So, it's been cool, but I don't know. I guess because of like the way I grew up, I have a lot of contacts throughout the university and so it's been nice. I feel like I've had more opportunities for some of the things*. (DS #4, Entry Phase, Teaching focused career [Academia], Lines 130-131).

Participants further described how future careers with their degree required special insight that 'outsiders' such as Career Services could not provide. For example, one participant mentioned how insiders such as faculty know the process of getting hired because they have personally been through it and they may have experienced being on a hiring committee. They said:

> *So, maybe this is just my close-minded, ignorant Ph.D. candidate who thinks he knows everything self. Like, maybe that's just how it is, but I'm assuming that my advisor who got hired four years ago, and the new guy in our department, and all these people, I'm assuming they know how to get a job better also because they're on the hiring committee. Who else is gonna tell me how I'm gonna get hired better than those that are actually hiring? So, those in the Career Center, they're like, "Oh, yeah..." I just feel like they'll say, "Oh, yeah, this is what they're looking for." But I'd rather ask the person actually looking than the Career Center.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 133-134).

A recent graduate also thought it was important to seek out the advice of professionals who were currently working in the field or career they wanted. For example, they said:

> *For advice for postdocs, I seek advice from my primary advisor, other faculty members, and then folks in the place where I want to work. So I've been to Boise and met with a couple of faculty members and researchers with the Forest Service research lab in Boise, and asked for their input, and what do they recommend for what I should be focusing on in a postdoc, who are good people to work with, where am I likely to be the most productive. That's where things are really trying to get direct feedback for the people who I would be engaging with.* (DS #5, Recent Graduate, Service focused career [Academia], Line 130).

While most of the engineering doctoral student participants were either unsure or doubted the ability of Career Services to help them with tasks like creating a CV, this perception ran counter to what university staff stated. This discourse will be discussed in Section 4.2.2.

<u>Recruiting Students</u>

The central focus on research was often a vehicle to recruit doctoral students who had an intrinsic interest in research, which was most likely gained through prior undergraduate experience. It was predominantly faculty or other insiders who recruited the participants into a doctoral program. Eight out of nine participants mentioned a faculty member (typically their major professor/research advisor) as a major contributing factor in their decision to pursue a Ph.D. This was true for both participants who had initially considered a Ph.D. and for those who had never considered it. Most participants mentioned that, before pursuing their Ph.D., they only wanted a master's degree for various reasons such as increasing their job prospects. However, at some point in the process of attaining a master's degree (before, during, after), they were convinced by insiders to pursue a Ph.D. In several cases where the participant went directly from their undergraduate degree to pursuing a Ph.D., they were encouraged by a professor in their engineering classes to pursue an advanced degree. In one case, a student described how a new professor in their department reached out to them after class and asked them to get involved in voluntary research as an undergraduate. This evolved into a paid position and eventually entry into their doctoral program. When asked about their decision to pursue a Ph.D., another participant remarked how they were only going to pursue a master's degree, but their advisor's consideration and persistence changed their mind. They said:

> *Halfway through my master's, my adviser came in though and he said, "There's this fellowship I'd like to submit your name for." And I said, "Don't waste your time. I'm not doing a Ph.D. I've been here too long." And he said, "Well, don't say no yet. Just think about it." And so, I said, "All right. I won't say no yet, but I'm not going to do it." And so, I went home, and I started thinking about it. And I didn't really wanna do a Ph.D., but I just...it's like when you have that feeling of something you should do, but you don't wanna do it. I had that feeling. And so, I decided that if I got the fellowship, I would do it. And so, I got the fellowship and here I am. I don't regret it at all.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 44).

One participant noted that this encouragement by an insider was important because it indicated they were capable of pursuing a Ph.D. For example, they said:

> *And that was the first time I've ever really thought about, you know, getting a Ph.D. or, you know, qualifying to be smart enough or whatever it was, but that was just kind of a boosted confidence that has just kind of stuck in the back of my head.*(DS #3, Recent Graduate, Engineering focused career [Various], Line 49).

While the participants mentioned their families, friends, and significant others in their interviews as factors in their decision to pursue a Ph.D., they were described as supportive of the decision to pursue a Ph.D. rather than an explicit motivation.

Teaching as Secondary Function

Participants generally accepted that research-associated skills, values, and tasks were important, but many also commented about how a focus on research can often supersede other job functions such as teaching. This was especially important for students who intended to pursue a career in academia. These participants described how they did not have many structured opportunities to develop teaching skills within their doctoral programs, and they attributed that to an institutional lack of value for teaching compared to research. When asked about the skills that were most important to their chosen career (i.e., academia), the participant focused on research skills, but then stopped and interjected:

> *Now that I've been talking about it, I realize my field is in academia and faculty, but I'm only talking about research which just shows how much a skillset in teaching is not completely valued. But I think [...] the skills that I can bring to the classroom are important. Do I think my Ph.D. program has really helped develop those skills? I'm not sure.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 93).

Even a student in the first semester of their doctoral program was aware of this lack of emphasis on teaching skills or functions. They stated:

> *Even if you're looking into going into research, you'll still have to teach at least one class. There are very few professors who get away with not teaching anything. And I think we do a poor job of preparing grad students in general to become teachers*. (DS #4, Entry Phase, Teaching focused career [Academia], Line 79).

Participants interested in academic careers strictly for their teaching functions acknowledged that positions such as Lectureships existed, but they were not afforded the same level of influence as academic positions that required a Ph.D. For example, one participant stated:

> *So, I am interested in an academic appointment. I actually worked in academia, but I was a non-tenure track faculty. I didn't have that Ph.D. credential and so I could see how actually being in that tenure-track really gives you that much more...what word am I looking for? That much more...say that much more could...like a better credential at that level. And so, I knew eventually I would want that title in order to try to have more influence over the academic world, I guess*. (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 34).

Further results on the participants' perception of teaching functions and a perceived misalignment will be presented in Section 4.1.1.2.2 Individual Negotiation of Doctoral Identity.

4.1.1.2 Perceived Fit

When considering an engineering doctoral identity, participants also had to consider whether they 'fit' within that identity both in the present and for their future careers. Doctoral student ‘fit’ was analyzed from a Person-Vocation perspective applied to doctoral education (Baker & Pifer, 2015). Fit in this context means a doctoral student’s fit with their academic experiences and perceived career options, which comes from their professional experiences and associated learning environment. These learning environments, like doctoral identity, are predominantly defined by insiders. However, a student’s perceived career options can also include fit with employers and careers outside of academia. Employers of engineers were not interviewed, and so their perceptions of Ph.D. recipients cannot be presented. However, doctoral student participants had opinions and perceptions of how those engineering employers viewed them. Participants believed that non-academic employers perceived that an engineer with a Ph.D. as highly intelligent and capable, but that they also might have stereotyped opinions of Ph.D. recipients which could affect their personal fit with certain types of jobs upon graduation. In considering their own fit, participants had to negotiate between what is valued by insiders. This included their alignment with research careers, misalignment with teaching careers, and how to integrate service functions into their intended careers. Finally, participants showed an awareness of this negotiation of fit in their ability to navigate academic cultures and follow hidden norms. Participants who were aware and willing to adhere to these hidden norms demonstrated commitment to pursuing academic careers while some participants expressed how the requirements of academia did not quite fit with what they wanted in their future career.

Outsider Evaluation

Engineering doctoral identity was also influenced by individuals who do not have Ph.D.s and/or are outside of engineering. These individuals can be engineering employers who are assessing the utility of hiring candidates, friends, family, and university staff within offices that offer career services or have professional responsibilities towards graduate students. These individuals were coded as ‘outsiders’ because they do not define engineering doctoral identity, but they may assess the utility of an individual with a Ph.D. in engineering. Participants were aware that if they intended to apply for non-academic careers, they would potentially be assessed by Outsiders who may not know what a Ph.D. entails. Thus, they had to consider their fit with outsiders.

Employers’ perception of Ph.D.s

While insiders took precedence in defining an engineering doctoral identity, participants were cognizant of being evaluated outside of academia (e.g., industry, government), especially when pursuing employment. Generally, participants believed that non-academic employers perceived their Ph.D. status positively, owing to greater experience, skills, and knowledge. Participants believed that having a Ph.D. would allow them to start at a higher status and salary than other engineers with a bachelor’s or master’s degree. Where a bachelor’s or master’s recipient would have to prove their capability over years of work, a Ph.D. at inception meant they had proven themselves as capable through their degree and the experiences inherent in earning their degree. This positive perception manifested in a rosier outlook for their future job prospects in non-academic fields. For example, when considering how a Ph.D. affected their future employment opportunities one participant noted:

> *For me personally, I think I could do well in the same type of job I could get with a bachelor's degree, with just a bachelor's degree and same with a master's degree. But it opens up new opportunities as well. And different types of*

> *opportunities too.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 51).

Another participant also thought the Ph.D. gave them an advantage. They stated:

> *I think it would put my resume higher up in the stack of...because I've looked into applying for jobs that I know other Ph.D.s were applying for. And this was after I had my master's and I was like, well, this job's probably going to go to a Ph.D. or someone, you know, whose done more work than I have and has demonstrated their research capabilities better than I have through a Ph.D. degree. And so that's why I think that getting a Ph.D. would be beneficial for me when I'm job searching a couple of years from now.* (DS #6, Integration Phase, Research focused career [Government], Line 30).

Another participant thought that the title of Ph.D. conferred a level of respect and autonomy. They stated:

> *I do think that it opens the door to getting into those research and conceptualization types jobs sooner, whereas entering a bachelor's or master's, it might take you a few years to gain up the trust of the company to let you have more of these hands-on and more responsibility in the design space. Whereas coming into a company with the doctor affixed your name kind of gives an inherent, you know, whether that's justified or not, it gives a manner of respect that I think companies are willing to give you more responsibility earlier in your career.* (DS #7, Integration Phase, Research focused career [Various], Line 42).

On the other hand, participants mentioned the dual nature of the appraisal of Ph.D. recipients. Because a Ph.D.'s status, abilities, and desired salary was greater, employers could view them as inefficient, which could limit their job prospects. While a Ph.D. recipient was qualified for the same jobs that a bachelor's. or master's degree recipient was, their actual employment options were limited both by their own perception of their degree and outsiders' view. One recurring concern with participants was the outsider perception of being overqualified. For example, the participant who spoke about the Ph.D. opening up opportunities also said:

> *So, I think I still could do those other jobs. The question though, is would I be hired? And I don't know. And I've heard mixed reviews on that. That sometimes, an employer will say that you're overqualified and they won't hire you. But I've heard other people say that it's not as big a deal as long as you're willing to, you know, maybe not get paid as much or something like that.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 57).

Another perception that participants felt they had to fight was that non-academic employers saw their graduate student experience as not equivalent to working experience. For example, one student described their experience speaking with employers at a career fair. They said:

> *As I was doing my undergrad, I was considering doing graduate school. And I would ask employers just at career fairs or things like that what they thought, like are they interested in looking for graduate students or are they just wanting bachelor students. And it was about 50/50 split from what I noticed, those that said that they liked that, that they were hiring master's students or even Ph.D.s and then others that were like, "When I see someone who has a graduate degree, I just see someone who likes to go to school." And so, there were certain people who were hiring who did not like that. They just wanted someone who was more work-oriented, I guess, and not so much with the academics.* (DS #9, Integration Phase, Research focused career [Academia and Industry], Lines 32-33).

While most participants were split on how they believed non-academic employers perceived them some attributed that perception to stereotypes or misconceptions about Ph.D. recipients. For example, when considering how industry employers viewed engineers with a Ph.D., one participant commented:

> *I think there is a level of, I don't know, respect or trust in the work of a Ph.D. but I think it also, in some ways, it borders on an idea that you give a project to a Ph.D. it might not ever get done because of the perfectionism required with it. So I think that might be the general, the feel, in the industry of you do a Ph.D....you know, if you hire a Ph.D., you get a huge amount of skill set, but then you might also get the downside of too much skill...I don't know from comments working with different employees in their various internships I've done, that kind of seems like depending on the person, they're like, "Oh goodness, a Ph.D.." It's like, "We'll get a good answer, but we'll get it in 17 years." So sometimes there's always that joke that, you know, going around too*. (DS #8, Integration Phase, Research focused career [Various], Line 46).

Perceived Fit with Outsiders

While participants acknowledged that some Ph.D. recipients would be willing to overlook salary or other factors, employers may still perceive the potential candidate as a risk if there is a mismatch in job function or the needs of industry. This was exemplified by some participants’ belief that industry was focused on creating products while a Ph.D. was mainly concerned with theory. This product vs. theory view resulted in the perception that Ph.D.s were inefficient, which was exemplified by the rigorous nature of how Ph.D. students are trained to do research and the high value placed on precision. However, participants noted that employers may perceive a mismatch in what they require from an employee and what an engineer with a Ph.D. may demand. For example, one participant commented on how a Ph.D.’s technical depth can inhibit an individual’s performance in a job suited for bachelor’s degrees. They said:

I think oftentimes Ph.D. students can be too focused, or those with Ph.D. could be too research-oriented for the field, at least in structural engineering and focus more on making things. Especially where we're in a world where we're dominated by the code, you have to live by the code, many engineers with a bachelor's or even master's will just *do things by the code and not think of how it's done, whereas a Ph.D. student is inclined to think why are doing what we're doing and maybe think too much about it*. (DS #1, Candidacy Phase, Teaching focused career [academia], Line 30).

Another participant remarked on how a Ph.D. recipient should be self-aware of what they wanted within a job and realize that a job could be a bad fit for them. They said:

> *I think in some ways that [a Ph.D.] could limit your employment depending on the type of employment you're looking for. I think that some people, it depends on the company you're looking for and their goals because I think some companies don't focus heavily on research and development. So, they might not consider a Ph.D. candidate because they might think they're overqualified or they don't wanna pay them as much as a Ph.D. might wanna get paid or they might be afraid that they would leave because they'd find the work to be boring or unstimulating and things like that. So, I think in some ways it narrows down the types of jobs or companies that you could look for. But if you were able to...you know, are self-aware at the beginning, you might realize that those were the only companies you'd care to work for anyways. And so, if you're doing a Ph.D., then that should help you get the job that you want.* (DS #8, Integration Phase, Research focused career [Various], Lines 40-41).

Participants remarked how engineers with Ph.D.s should consider how their aptitudes gained in a doctoral program fit with the job description and expectation. Participants mentioned how jobs meant for bachelor's or master's recipients in engineering could be constraining especially if the position did not involve research or developing new solutions to problems. While Ph.D. recipients could apply to these positions, both they and the employers would be unhappy with the misalignment between skills, compensation, and job function. As participants noted, the Ph.D. degree simultaneously opened up the careers they were qualified for that are unavailable to bachelor's degree graduates (especially involving research), but it also narrowed the types of jobs they would apply to. A recent graduate described some of the challenges they were facing when applying for jobs in their field. They stated:

> *So, in my particular situation, I'm looking for a job in a specific location. And there are so many engineering jobs in the city. Of the jobs that are there, I would say 90% to 95% of them are suitable for someone with the bachelor's or a master's degree. And those have high turnover rates or many of them, they're also, their openings come up much more frequently. And there are maybe 5% to 10%, which are eligible for someone with the Ph.D. So yeah, I'd say, I feel like I'm overqualified for the vast majority of job opportunities that I've seen in this particular city.* (DS #5, Recent Graduate, Service focused career [Academia], Line 40).

4.1.1.2.2 Individual Negotiation of Doctoral Identity Fit

Each participant had individual and unique prospective career paths based upon their current doctoral program context and how they envisioned themselves in a future career. Concomitantly, participants had individual preferences on general aspects of employment (e.g., salary, benefits, work-life balance). These general aspects could apply to any type of employment within any field and were coded as Job Fit characteristics (e.g., location, work culture, type of job).These Job Fit characteristics were elicited by directly asking participants what was important to them in terms of employment quality and by asking them to consider what compromises they would make in accepting their first job after attaining a Ph.D. Job Fit characteristics were also coded throughout the entirety of participant interviews if they emerged unsolicited. A summary of the total number of Job Fit characteristics codes arranged from most to least frequent is provided in Table 4-1. Participants averaged approximately 20 Job Fit characteristic codes per interview, which means they brought up a general aspect of future employment that was important to them about 20 times in their interviews. Of those Job Fit characteristic codes, type of work and location were the most frequently coded with all participants (9 out of 9) mentioning type of work and nearly all (8 out of 9) mentioning location as important to future employment. Job Fit characteristics codes were also broken down by Phase of Doctoral Development and Preferred Career Function and included in Table F-1 in the Appendix.

Table 4-1. List of job fit characteristics codes important to participants.

Job Fit Characteristic	Total # of Codes	Total # of Participants
Type of Work	35	9
Location	34	8
Work-life Balance	24	8
Work Culture	32	8
Financial Considerations	16	7
Helping Others	13	6
Flexibility	7	5
Job Prestige	6	5
Independence	6	4
Commute & Logistics	6	3
Promotion & Career Trajectory	5	3

A visual representation of the frequency of important Job Fit characteristics by participant is provided in Figure 4-4. Figure 4-4 is a screenshot of the code matrix browser within MAXQDA 2018 (VERBI Software, 2017), which is a visual tool which shows frequency of codes by participant in relation to other codes. Larger squares represent a higher frequency of codes and thus relative salience to a participant. From this visual representation, it can be observed that participants have unique preferences for Job Fit characteristics (e.g. DS #7 prefers location, family consideration, and type of work).

These Job Fit characteristics are not completely independent of each other and helped frame others. For example, ‘family considerations’ emerged as a subcode for ‘work-life balance’ because of the high value many participants placed on having children, which is culturally and contextually relevant for the location of this study. ‘Family considerations’ was coded separately from ‘work-life balance’ for family specific work-life balance fit characteristics and combined for frequency counts in Tables 4-1 and Appendix Table F-1. A breakdown of participant job fit characteristics for phase of development and career function is also provided in Appendix Table F-1.

Participants saw Job Fit characteristics in a more holistic sense that supported their overall employment and life objectives and thus these Job Fit characteristics typically aligned with a larger goal. For example, when discussing what job characteristics were most important to them for future employment, DS #7 narrowed it down to two core values: supporting their family and the type of job that they would enjoy. When they elaborated further, they mentioned the importance of workplace culture and how that would affect their time with their family (i.e., work-life balance, family considerations) which in turn made academia an attractive career option for them. When asked to clarify about workplace culture they responded:

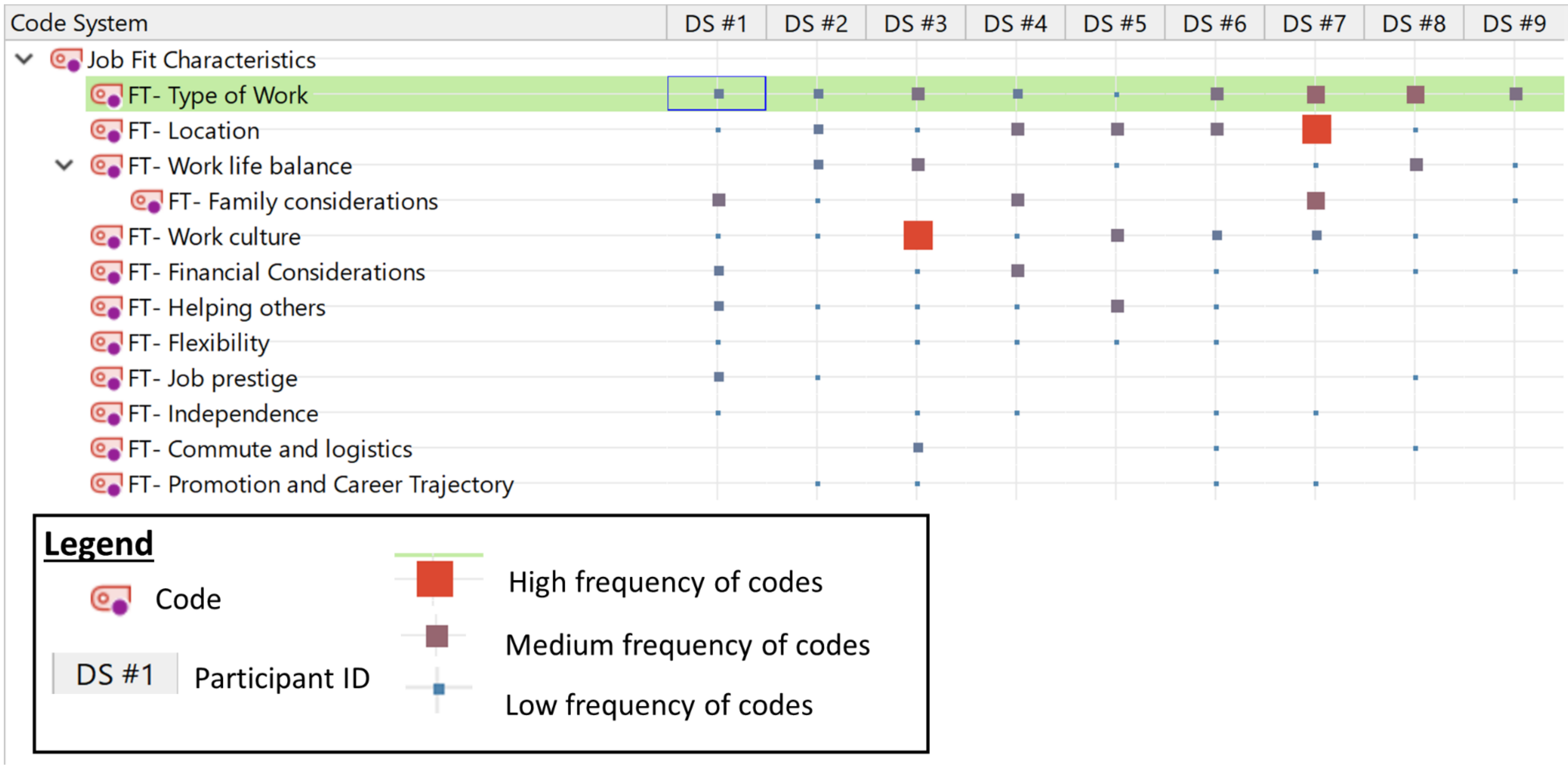


Figure 4-4. Screenshot of MAXQDA 2018's code matrix browser (VERBI Software, 2017) of Job Fit characteristic coding frequency by participant.

> *I want a place where they value growth. And the work-life balance falls under culture as well. And the way that, like my lifestyle, and the way that I want to live, I want that to be seen as acceptable and okay, you know, in the job that I will get. Some wouldn't be, you know. I do think for most it is. Like I think most employers will make sure there's a good work-life balance. And it's okay if you need to take off to go take care of your kids and stuff. And also, one of the attractive things about academia is that I don't have like a set schedule every day. And as long as I get my work done, it doesn't matter if I need to take the morning off. You know, and I don't have to take like vacation time for that. And I can work from home a lot too. So, I'm kind of my own boss in a sense, I guess. And that's an attractive thing for me in the job too, is having some freedom on how I set my schedule. And that ties back to the way I spend my time with my family. Again, I feel like most jobs will let you kind of set your own schedule within limits. But there's some jobs that let you do that more than others.* (DS #7, Integration Phase, Research focused career [Academia and Government], Lines 148-150).

Participants of all stages of development (i.e., entry, integration, candidacy) and of all intended career paths were in the process of making sense what it meant to have a Ph.D. within their field and how that would affect their future careers. While they mostly internalized the norms and values of insiders such as faculty, participants found some tasks, values, and messages difficult to reconcile with what they wanted out of their intended career path. This was exemplified by both students pursuing all types of career paths through the types of career functions they were primarily interested in (i.e., research, teaching, service, engineering). When considering their future careers, most of the participants were flexible in what sector they would be willing to work in (e.g., academia, industry, government), but they were more intransigent on the type of work they wanted to be doing. The majority (7 out of 9) of participants were interested in either research or teaching as their desired career function, one was interested in careers focused on helping others outside of teaching (i.e., service) and the last was interested in the direct application of research (i.e., engineering). A summary of the participants and the types of careers they are pursuing or interested in pursuing is provided in Table 4-2, and a corresponding graphic is provided in Appendix F.

With research as a central aspect of engineering doctoral identity, participants who were pursuing research-type careers were more aligned with the requirements and outcomes of their doctoral programs. On the other hand, participants who were interested in teaching and service functions expressed the most dissatisfaction with structured opportunities for developing those skills within their programs. The engineering career function participant did not indicate whether their career needs were aligned or misaligned with their doctoral program because they were already employed while seeking their degree. They stated:

> *[…] Because I have a job. And I mean, and I have a career, right? It's not just I have a job, like I have a career in engineering that's going very well. And so, I don't feel like I have strong needs that I'm looking for the university to fill. Like if I was a, you know, just trying to imagine if I was a newly-graduated Ph.D. especially, well probably any Ph.D., technical or otherwise, you know, I'd be wanting probably a network type links in academia, you know, who can I talk to, just looking for somebody that does research in this area, you know, and then on the technical side, especially, you know, what businesses are looking for stuff like this*. (DS #3, Recent Graduate, Engineering focused career [Various], Line 139).

Table 4-2. Participant preferred career functions and career sector.

Participant	Development Phase	Primary Career Function	Preferred Career Sector	Also Considering	Most Important Job Fit Characteristics
DS #1	Candidacy	Teaching	Academia	Industry	FAM, TYPE
DS #2	Candidacy	Teaching	Academia	N/A	WORKLIFE, PROMOTION, LOC
DS #3	Recent Graduate	Engineering	Various/Undecided	Industry, academia	WORKLIFE, WORKCUL
DS #4	Entry	Teaching	Academia	Industry	WORKLIFE, FINANCE
DS #5	Recent Graduate	Service	Academia	Government, NGO	LOC, WORKCUL
DS #6	Integration	Research	Government	N/A	FLEX, LOC, TYPE
DS #7	Integration	Research	Various/Undecided	Academia, government	WORKLIFE, TYPE, WORKCUL
DS #8	Integration	Research	Various/Undecided	Academia, industry, government, etc.	WORKLIFE, TYPE, LOC
DS #9	Integration	Research	Various/Undecided	Academia, industry	WORKLIFE, TYPE

Note. FAM= Family Considerations; FINANCE= Financial Considerations; FLEX= Flexibility; LOC= Location; PROMOTION= Promotion and Career Trajectory; TYPE= Type of Work; WORKLIFE=Work-life balance; WORKCUL=Workplace Culture

Research Career Alignment

Four participants were primarily interested in research as their main job function. Three more participants potentially saw research as part of their future duties either because it was required (e.g., tenure-track academic position at a research institution) or it supported their primary job function (e.g., research to assist humanitarian projects). These participants' career aspirations were more flexible, and they were considering academic, government, industry, and atypical career paths (e.g., FBI agent). They saw academia as a viable option because of the focus on research as well as several other job fit characteristics specific to each individual's unique career wants and needs (e.g., location, work-life balance). When asked about their long-term career goals and aspirations, one participant explained that they had a slight preference for academia, but they were equally open to a position in industry. They said about industry careers, "I could see myself doing that. If that kind of path opened up to me, I would consider it just as much as I would any job in the industry." (DS #9, Integration phase, Research focused career [Academia and Industry], Line 54). When pressed further for clarification, they focused on whether the prospective career involved research, even expanding their career prospects to conducting research in a government lab. The participant continued:

> *I do think some of those big companies have research positions. I don't know how easy it would be to get into one right off the bat. So, I guess that's where I stand on it. I'd probably lean towards academia, mainly for that research side to be able to keep doing research. But I do believe there are companies out there that are looking for research. One thing that intrigues me more now that I am a doctoral student is kind of like a small startup or small business. I think a lot of those might have a lot of options for a lot of research with a lot of R&D, and I think that would be very enticing for a job*. (DS #9, Research focused career [Academia and Industry], Line 59).

Another participant was less flexible in where they wanted to work. When asked about their long-term career goals and aspirations they responded:

> *I mean, I'd like to continue doing research. It would be great if it could be at a government institute, like any of the USGS research centers or any research institute that's, like, closely affiliated with a university. I'm not sure that I want to be an academic. I haven't taught any coursework and TA'd in anything. And that's one thing I would hope, I'd like to get out of this Ph.D. program is an opportunity to teach so I know whether or not, like, "Oh, that wasn't that bad," or "Yeah, I'm definitely staying away from that," you know. So, but currently, that's academia. Staying in academia is not my plan.* (DS #6, Integration Phase, Research focused career [Government], Line 61).

Another aspect of perceived alignment with research careers was on publishing papers. Participants across all disciplines showed a heightened awareness of the importance of publishing their research within their field. While this affected participants interested in teaching, research-focused career participants also felt heightened pressure to perform these tasks inside and outside their degree program requirements. When describing the dissertation process, one participant described its limited usefulness for a future career path that is not in academia. They said:

> *Your dissertation is literally just showing that you get the Ph [i.e., Philosophy] part of your doctorate that shows you understand the philosophy side of here's what's valued. I can identify something that's valued in the community, I can identify research methods that the community will approve of that will answer this question and then I can execute it. That's really all you're showing. You're not, you know, because people talk about, "Oh, you got to add to the knowledge base of the community and blah blah blah." And so, you're not trying to go, "What could really work, you know, what could make the biggest difference for the community?" And that's not what the dissertation's about. Like it's... Okay, so it'd be amazing if you did that, but I don't think most Ph.D.s are trying to get a job out of their dissertation. Like, yeah, it's kind of setting you up maybe for a direction to*

> *go with your research in the future, but a lot of it is really just showing you know what to do. Especially if you're like me and you're not 100% sure you wanna go into academia anymore. It's like, "Ah, is anybody gonna read my dissertation that I'm asking to pay me money in the future?* (DS # 3, Recent Graduate, Engineering focused career [Various], Line 119).

This participant could see how a dissertation might inform the future research direction of an academic, but they saw limited usefulness for other types of careers. Instead, they stated that the dissertation was used to prove research aptitude to other people with Ph.D.s (i.e., insiders). Participants, especially at the more advanced stages of their program, knew how highly insiders value publishing conference papers and journal articles and how that would affect their day-to-day activities. When asked what a participant wished they knew before enrolling in their doctoral program, they brought up the amount of academic writing especially in regard to conferences. They said, “All of your research is based on, like, you know, you need to write a conference paper, journal paper, and do this and that or your dissertation thesis.” (DS #8, Integration Phase, Research focused career [Various], Line 66).

Teaching Career Misalignment

Five of the nine participants were considering academic career paths, and specifically tenure-track positions. However, despite acknowledging such careers will likely demand a focus on research, several of these participants were primarily interested in the teaching functions of academia over research. Many participants struggled with finding opportunities to develop or further develop teaching skills that they personally valued. They cited knowing opportunities on campus existed (e.g., teaching assistantships, graduate training series [GrTS] seminars offered by the School of

Graduate Studies, education classes outside their discipline), but they had to seek out these opportunities on their own time and sometimes in conflict with their degree progress. When asked about what skills they have not had time to develop one participant expressed:

> *I would say that the biggest hole in my experience as a person who wants to go into academia is teaching. I think that oftentimes in academic positions, it's kind of just assumed that if you know the material, you can teach it, but that's obviously not true. So, I'd say that's the biggest hole and skillset development that I've had in this program. I have taken the opportunity to guest lecturer in courses, and I've TA'd for labs to try to build up that experience. It's not necessary. It's not mandatory. It's not a common set of experiences that folks in a Ph.D. program receive, which I think is a shame.* (DS #5, Recent Graduate, Service focused career [Academia], Line 109).

They further explain that they developed the curriculum for a three-day short course focusing on discipline specific engineering concepts as part of a 12-week program to help students from China improve English skills, but they only had that opportunity because of a personal connection to someone in the Intensive English Learning Institute. The participant further stresses that developing skills that are not as valued to the production of research (e.g., teaching) is left solely to the student's awareness of those opportunities and their ability to individually seek them out. They said:

> *I mean, as a research-heavy school, if the idea is that doctoral students are leaving here to get positions similar to the faculty here than just leaving the teaching component on the individual, it seems like an oversight. Again, I think it's just where priorities lay when it comes to evaluating faculty. If there was more emphasis on being good teachers, then maybe it would be worth the university actually investing in producing candidates who have a track record of good teaching, then you could build a school. It's not only a good research school but*

> *also a good educational school.* (DS #5, Recent Graduate, Service focused career [Academia], Line 119-120).

Another participant went out of their way and submitted five corrections to their program of study to take courses offered by another department (i.e., Engineering Education) to develop teaching skills, but still expressed some frustration that developing teaching skills as a graduate student was not institutionalized. They said:

> *I wish that the teaching courses were mandatory because I don't like seeing people unprepared to teach. Just because you have a Ph.D. does not mean you're qualified to teach. That's absurd. So, I wish that other Ph.D. candidates were required to take certain...like, I wish there were preparation courses for teaching.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 63).

Participants were aware of the university's emphasis on research at the expense of the job function that most interested them and worked within and outside of their departments and the institution to find a way to develop those skills. Even when participants were in programs that specifically offer and require taking education courses (e.g., Engineering Educations), some participants expressed frustration with a focus on research activities despite their coursework and other requirements.

<u>Service Integration into a Career</u>

While teaching and research functions of careers were predominantly mentioned, some participants brought up careers with service-like functions such as helping others or bringing changes to their respective fields. These service functions were predominantly secondary to research or teaching roles, but participants factored them into their eventual career path. Participants from multiple disciplines considered using their research or teaching positions to help others. When asked about their long-term career goals and aspirations, one participant responded:

> *To work for a public agency or a private agency, working to solve problems that affect folks who don't necessarily pay for the research themselves, but benefit from it. […] I want to have some application back to, say, people in need. So, I guess my long-term career goals are to establish a research lab, train students, teach, and also be involved with humanitarian projects, whether that be at the federal level or with NGOs that I believe in.* (DS #5, Recent Graduate, Service focused career [Academia], Line 77).

While DS #5 envisioned working in academia and achieving their service-focused aspirations, another participant brought up how the academic environment was not ideal for them. They stated:

> *Well, I think I like the more relaxed feel of a federal agency or, like, in a research institute and just, like, I think I'd like that atmosphere more. The idea of, like, trying to balance applying for grants, and teaching classes, and then writing papers, and managing master's and Ph.D. students, it just seems a little daunting and, like, not really something I ever saw myself doing anyways. I mean, I only ever considered myself working at...I've always wanted to work at a federal agency and be, like, a civil servant.* (DS #6, Integration Phase, Research focused career [Government], Line 63).

Other participants focused on helping students beyond tasks associated with teaching. One participant wanted to eventually be in a position of influence to change the engineering curriculum on an institutional scale. When considering what was important in terms of employment quality, this participant expressed the importance of finding an institution or organization that shared their values or allowed them to pursue these service-associated functions and how that affected their career trajectory to become someone who could enact change. They stated:

> *So, there's this next step, career step. I mean, it could be postdoc or full-time faculty, but I want it to be a step that is going to set my career on a good path. And so as far [my discipline], what I feel like that means for me is finding a program that is interested in what [my discipline] can bring to the school and finding a program that is actually interested in having changes at that curricular level or the classroom level, not just programs that are interested in research aspects of what I could bring. And so I think that's going to be important when I look at what careers I want, because I want a career or I wanna take...I don't wanna have to start somewhere and then realize, oh, they don't actually align with where I'm trying to go and then have to find a different job somewhere else. So, I guess it's kind of career trajectory and kind of alignment with my interests.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 108).

Another participant reflected on their dissertation and how they initially wanted to use it to help others but was counseled by a friend with a Ph.D. to consider what they could realistically accomplish. They said:

> *I'd had a buddy, you know, I've got a good buddy of mine who's got a Ph.D.—he's a CEO of a small corporation here in the valley—and we were chatting and he's like, "Don't try to change the world, [DS #3]." And this was back when I had the [dissertation] idea that I was trying to do. He's like, "Don't try to change the world." And, you know, he could sense that it was too big. And I was like, "Yeah, but this is why I came back, right? I quit a high-paying job to go, you know, work part-time as an engineer and kill myself trying to do a Ph.D. assistantship at the same time because I wanna change the world. That's why I'm doing this.* (DS #3, Recent Graduate, Engineering focused career [Various], Line 66).

Navigating Academic Culture

Regardless of intended career trajectory, the participants showed various levels of awareness and willingness to work within their current context (e.g., departments, institution). Some planned to use the values and aptitudes of academia to eventually achieve their objective (i.e., DS #2, DS #5), others refused to consider academia as a career path because of the perceived mismatch in required tasks (i.e., DS #6), and others struggled with incorporating their future career ideals such as teaching functions within their current doctoral context (i.e., DS #2, DS #1). Concerning the latter, participants had to find or make opportunities to develop matched aptitudes for their intended future careers (e.g., taking education classes to gain teaching skills) and other participants focused on meeting explicit and implicit degree requirements (e.g., changing dissertation focus and objective). Participants, regardless of the alignment between their preferred career function and departmental culture, had to navigate the implicit and explicit values of the academic culture that dictated programmatic requirements that they perceived were not ideal for them.

Phase of doctoral development also affected their perceived alignment or misalignment between their respective departmental cultures and future profession. Doctoral candidate and recent graduate participants were more aware of how their ideal career was in conflict with their current reality. This reality could be having to meet university requirements or what they perceived as possible with their current awareness or level of expertise. This was particularly salient when participants considered how competitive they perceived the job market to be in academia and outside of academia. One Ph.D. candidate seeking employment in academia worried about their lack of published journal articles and how that would affect their chances of getting a tenure-track position. They even considered a short-term postdoctoral position that they did not want if that would get them more publications. One doctoral candidate had a detailed description of how and why they did not want to teach in a lecture-style and convert to active-learning or flipped classrooms. However, when considering the reality of this, they specifically brought up tenure and how tenure-seeking faculty are evaluated and their lack of experience in teaching. They said:

> *So, if tenure takes four years, five years, six years, I'm assuming first years are going to be mostly lecture and then third year will be I'll start to flip classrooms. I don't know if that's too big a task, too much to take on. [...] So, I don't know. I think it just depends. If you're doing research though, if you're only doing one class a year, well, I don't know since if you have a heavier research emphasis, if it's like 60/30/10, 60, your research, 30, teaching, 10, service, what that really means, that means nothing, right? The numbers mean nothing from everyone I've talked to. It just means you have to be excellent in your top category, acceptable in your middle, and no one looks at the bottom category. That's what I've heard from the majority of everyone. So anyway, but if that's true then maybe I won't be able to do that until after tenure because teaching won't matter to them. It always matters to me, but I don't really know. My goals, long-term goals, it goes back to the long-term goal, I wanna get a job, I wanna keep my job. Right? Gotta live.* (DS #1, Candidacy phase, Teaching focused career [Academia], Lines 83-84).

On the other hand, a participant in the entry stage of development described an idealized career as a professor of practice with no research commitments with great work-life balance, benefits, and flexible summers. Participants in the integration stage were still idealistic but they also possessed more awareness of how their ideal career clashed with their current situation. For example, one participant wanted a faculty career at their current institution but mentioned that they wish they had known about the policy against ‘academic inbreeding’ (i.e., the university practice of hiring its own graduates as professors). They stated:

> *I wish I had known that. Because I probably, before we got into the situation we were in, I probably would've gone somewhere else for Graduate School altogether. And because I would like to get a job here. I'd love to settle here […]. I'm from [nearby town] and have a lot of family here. And so, it just feels like home, you know. And, if I had known that I think I might have gone somewhere else.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 91).

4.1.2 Theme #2: Engineering Doctoral Skill Development

The second major theme that emerged from engineering doctoral students was Engineering Doctoral Skill Development. Skills developed or further developed within doctoral programs were important both for a participant’s current success within their programs, but also for their anticipated success in acquiring a career of their choice. Participants developed skills through required tasks (e.g., degree requirements, assistantship job functions) and independently (e.g., seeking out extra opportunities for skill development). All nine participants described developing, using, or needing technical, communication, and teaching skills within their doctoral programs or for their intended future careers. Working independently (e.g., time management) and a knowledge of organizational culture were also salient across the four engineering disciplines. A frequency count of the *a priori* skills for engineering doctoral careers revealed that participants mentioned technical and communication skills the most (53 and 45 codes respectively) while interpersonal (4 codes), teamwork and collaboration (3 codes), and economic and commercial skills (2 codes) were mentioned the least. A visual representation of how frequently each participant mentioned each skill is provided in Figure 4-5. The larger the square, the more frequently that specific skill was coded. Participants emphasized some skills over others. For example, DS #1 who wants a teaching focused career in academia emphasized teaching skills over others. A full summary of the skills that participants developed in their programs, thought were important to their future career, and what they did not have time to develop is provided in Table 4-3.

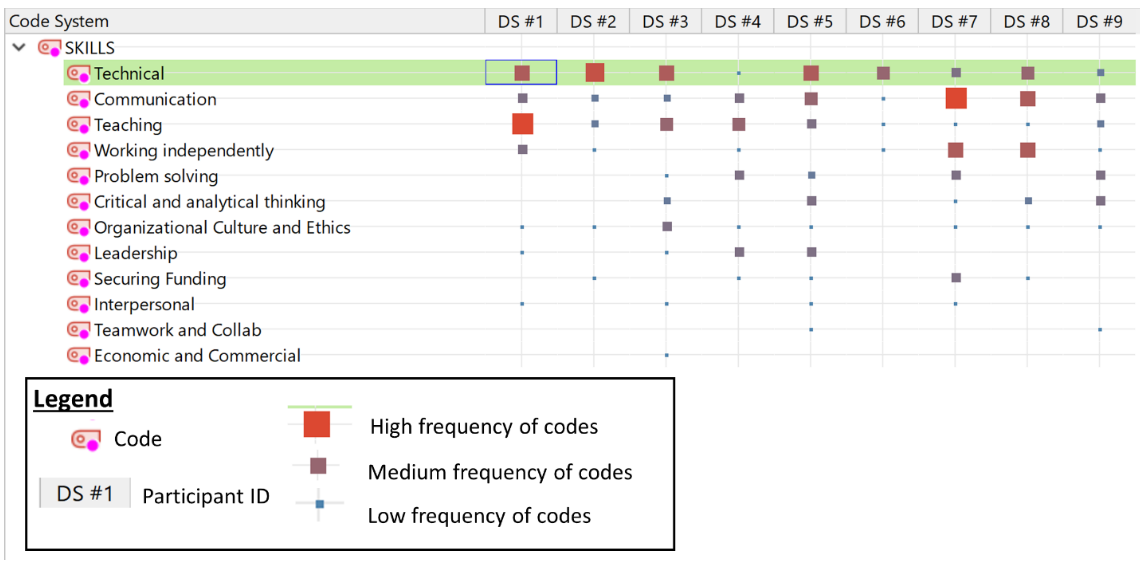


Figure 4-5. Screenshot of MAXQDA 2018's code matrix browser (VERBI Software, 2017) showing Engineering Doctoral Skill coding frequency by participant.

Table 4-3. Summary of participant responses to skill-specific questions.

Participant	Development Phase	Primary Career Function	Primary Career Pursuing	Skills developed in doctoral program	Skills most important for chosen career	Skills they have not had enough time to develop
DS #1	Candidacy	Teaching	Academia	TECH, TEACH, LEAD, ORG, IND, COMM,	TEACH, TECH, COMM, INTERP, IND	TEACH
DS #2	Candidacy	Teaching	Academia	TECH, COMM, TEACH, IND	TECH, TEACH	TECH
DS #3	Recent Graduate	Engineering	Various/ Undecided	TECH, THINK, ORG	No response	TECH, TEACH
DS #4	Entry	Teaching	Academia	IND	COMM, IND, TEACH,	COMM, TEACH
DS #5	Recent Graduate	Service	Academia	TECH, THINK, INTERP, TEAM, LEAD, COMM,	COMM	TEACH
DS #6	Integration	Research	Government	TECH, COMM, IND,	TECH, COMM	IND
DS #7	Integration	Research	Various/ Undecided	TECH, IND, COMM, ORG, PROB	COMM, FUND, INTERP, IND, TECH	IND, COMM, ORG, PROB
DS #8	Integration	Research	Various/ Undecided	IND, TECH, COMM, ORG,	COMM, THINK	None
DS #9	Integration	Research	Various/ Undecided	COMM, THINK, PROB	COMM, PROB, THINK	TEAM, COMM

Note. COMM= Communication, IND= Working independently, INTERP= Interpersonal, LEAD=Leadership, ORG= Organizational Culture and Ethics, PROB= Problem Solving, TEACH=Teaching, TEAM=Collaboration and Teamwork, TECH= Technical, THINK= Critical and Analytical Thinking.

4.1.2.1 Salient Engineering Doctoral Skills

During their interviews, participants were directed to reflect on the skills they had developed, what skills were important for their chosen career, and what skills they did not have enough time to develop. A frequency count of the *a priori* codes of the engineering doctoral skills taken from the literature review (Table 2-1) revealed the most salient skills for participants were technical skills associated with conducting research (e.g., developing research questions), communication skills (e.g., writing papers and presenting at conferences), teaching skills (e.g., developing curriculum), and working independently (e.g., time management). The least mentioned skills were interpersonal, teamwork and collaboration, and economic and commercial. The full list of *a priori* skills coded for the nine participants is provided in Table 4-4.

Technical skills ranged from describing how to develop research questions to discipline-specific modeling and analysis techniques. Technical skills were mentioned with high frequency (approximately 6 codes per participant on average) across all participants. For the majority of participants, technical skills were the first type of skill they mentioned in their interviews and were frequently described when prompted about the skills they had developed in their doctoral program. Communication skills were also salient to the participants across all disciplines (approximately 5 codes per participant on average). Seven out of nine participants listed communication as one of the skills they had specifically developed in their doctoral program. The other two participants mentioned communications elsewhere in their interviews. The specific communication skills participants mentioned ranged from writing publications to communication with non-technical and non-academic audiences.

Table 4-4. A priori skill code frequency count of total coded responses for nine doctoral students.

***A priori* skill code**	**Definition**	**Total # of codes**	**Coded in**
Technical (TECH)	Techniques that are required to conduct research effectively (e.g., statistical analysis)	53	9 out of 9
Communication (COMM)	The ability to convey information to an audience (e.g., writing papers)	45	9 out of 9
Teaching (TEACH)	The ability to impart knowledge or skill to someone (e.g., developing curriculum)	35	9 out of 9
Working independently (IND)	The ability to work with minimal guidance and think independently (e.g., time management)	26	7 out of 9
Problem solving (PROB)	The ability to define a problem, break it into parts, and customize a solution depending on the context (e.g., working through problems)	17	5 out of 9
Critical and analytical thinking (THINK)	Objective analysis and evaluation of a situation or problem in order to form a judgment (e.g., interpretation)	16	5 out of 9
Organizational Culture and Ethics (ORG)	The ability to adhere to standards of personal and disciplinary behavior, values, and guiding principles (e.g., codes of ethics)	15	8 out of 9
Leadership (LEAD)	The ability to guide or direct a group (e.g., motivating others)	11	4 out of 9
Securing Funding (FUND)	Thea ability needed to secure funding at an organization (e.g., grant writing)	11	5 out of 9
Interpersonal (INTERP)	The ability to interact with others harmoniously (e.g., resilience)	4	4 out of 9
Teamwork and Collaboration (TEAM)	The cooperative effort of people in a group who work together (e.g., working with others)	3	2 out of 9
Economic and Commercial (ECON)	The ability to incorporate economic and commercial factors into problem solving and decision-making (e.g., creating a budget)	2	1 out of 9

Out of the 45 codes for communication, about 38% mentioned communicating with other academics or researchers including writing publications (e.g., journal articles, conference papers, dissertation), presenting at conferences, or writing grant proposals. Examples of written communication extended beyond academic writing. For example, when asked what skills were relevant to their field one participant stated:

> *Writing in engineering, you're never gonna get away from it. It's probably gonna be at least 50% if not more of your time. And I think that would apply to even bachelor's degree engineers or even Ph.D. engineers. I think writing is gonna be a big part of what you do, so that's pretty critical.* (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 73).

One participant articulated the versatility of communication skills across all types of career paths by saying, "I mean, I think everybody writes in their career. Right. But maybe some more than others. And for me, with my idea of where I want to go, I'll be writing a lot." (DS #7, Integration Phase, Research focused career [Academia and Government], Line 227).

The third most frequently coded skill, teaching, was predominantly mentioned by participants seeking academic careers. However, despite its frequency, only two participants brought up teaching skills when directly asked what skills they had developed during their doctoral program. For example, one participant interested in an academic career responded:

> *Well, I obviously have done a lot of research because I haven't done a lot of teaching until now. However, I've done a lot of...I took [education] courses because I want to be prepared for that. So, I feel like I've developed teaching abilities and skills such as the ability to better assess performance and understanding of students. Course development, I've been able to understand that*

> *a little better. I feel like I'm able to create objectives, I guess focus my teaching more on learning outcomes that we'd like. So those skills are valuable.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 94).

Teaching skills were frequently mentioned outside of direct questions about skills when participants described their career goals or reasons for pursuing a doctoral degree. While the presence of participants in a discipline that specifically focuses on education accounts for some teaching skills codes, the majority (57%) of teaching skill codes were from disciplines that are not focused on education.

The skill of working independently appeared frequently throughout participant interviews. While participants mentioned many aspects of working independently, they focused on the specific skill of managing their time. Being able to manage and organize many tasks through limited hours in the day. One participant reflected on how time management is necessary to balance a personal life with pursuing a Ph.D. When asked what skills they had developed so far as a doctoral student they first mentioned technical and teaching skills and then said:

> *[...] Other skills, I think I'm doing decently on time management, but I think I'm forced to do that just because of kids and trying to get a Ph.D. at the same time. But that has been definitely a big change from like my masters say, so my master's, I could work whenever, however, on whatever, and now it's really I need to figure out what I need to focus on each day and just work on that. So that's probably been the biggest thing just throughout this entire program that I've...the skill I guess I really worked on*. (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 88).

Another participant reflected on how their status as a Ph.D. student and their personal skill of working independently resulted in more autonomy. When discussing the skills they developed throughout their doctoral program, they said:

> *I don't know how much is me personally or as a doctoral student in the lab, I think my professors have given me more of a longer leash, I guess, in terms of just looking at...Like, comparing to the different people in the lab, I feel like, I do a lot of solo work. Like, it's actually kind of funny. I met with my major professor for, like, the first time in eight months to specifically sit down.* (DS #8, Integration Phase, Research focused career [Various], Line 88).

They further discussed how there is a difference in their expectation and ability to work independently even compared to master's students in their department. They mentioned how master's students needed more 'handholding' or guidance than Ph.D. students due to the shorter nature of their programs and made their last point by saying:

> *Because [Masters students] are all capable of doing the work independently, but I think that, you know, whereas me and the other doctoral students have that little bit more space. But I think that might just be because we have plenty of time to fail and then start over and continue before we graduate.* (DS #8, Integration Phase, Research focused career [Various], Line 92).

Other skills were mentioned infrequently and rarely directly brought up as a skill participants had developed throughout their doctoral programs. For example, the skill of problem solving was brought up primarily when comparing engineers with bachelor's degrees to engineers with Ph.D.s. Organizational Culture and Ethics was coded for eight out of nine participants. However, participants did not explicitly mention developing this skill or its importance during their Ph.D. Instead, this was coded whenever they demonstrated an awareness of an organizational culture or utilization of this skill throughout their interviews. For example, one participant stated:

> *I think an academic environment often times is very politically charged and not that great. And I don't know how to avoid that. So, it's one of my other fears in going into academia. [...] But, yeah, the politics involved in academia are no fun. You know, in my old job we used to say the less money there is available, the more people fight for it, and the worse you treat each other. In academia maybe a very good case in point on that where there's less money available that's flexible. And people really fight and claw over it. I don't know.* (DS #3, Recent Graduate, Engineering focused career [Various], Line 117).

Interpersonal, teamwork and collaboration, and economic and commercial skills were rarely mentioned by participants. When participants mentioned interpersonal skills, they described social interactions between research teams or personality fit considerations for future employment. Teamwork and collaboration skills were mentioned in conjunction with working on larger research projects with other students and faculty or when reflecting on previous experiencing before joining a doctoral program. Economic and commercial skills were only brought up by one participant who worked as a part-time engineer while pursuing their doctoral degree and were mentioned in reference to a friend who had a Ph.D. in engineering who had to use these skills.

4.1.2.2 Career Function Skill Alignment

Participants were directly asked what skills were important to their chosen career and their responses were analyzed specific to the question and put into context with the total frequency count of skills coded. In response to the question, participants, while all pursuing various career paths and career functions, listed communication and technical skills as those important for their future career. Working independently was a skill listed as important for participants seeking teaching and research focused careers. Teaching and interpersonal skills were uniquely mentioned by teaching focused participants. Research focused participants mentioned more skills associated with conducting research such as critical and analytical thinking, problem solving, and securing funding (e.g., grant proposals). There were no skills unique to service focused careers mentioned by participants during their interviews. A diagram of the skills participant explicitly labeled as important for their future career by preferred career function (i.e., teaching, research, focused) can be observed in Figure 4-6.

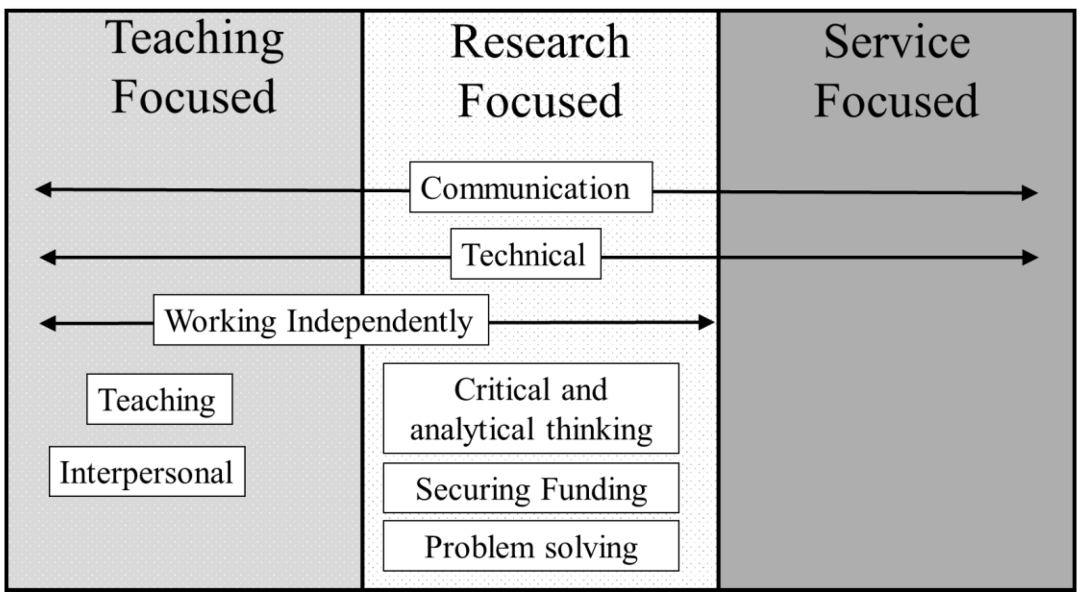


Figure 4-6. Participant reported skills that are important to their chosen careers.

Technical skills were especially important for participants considering academic careers or research focused careers in another sector (e.g., government). These skills were more explicitly mentioned by participants seeking academic careers. Participants, however, showed an awareness that the relative importance of these skills was dependent on what job function they would actually perform. For example, when asked what skills were important to their chosen career, this participant seeking an academic-career responded:

> *Well, if I'm gonna teach, then the teaching ones. But if I go into research, then the research ones. If I go into industry, then I guess the teaching ones probably don't matter that much. But, I mean, it could be useful when I begin training other engineers. But I'd say probably my research would be most useful for both research field and for industry.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line #97).

Another participant described skills that would be useful if they ended up in industry despite their slight preference for academia. They said:

> *If I decide to go into the position in the private sector, say, which is not high on the list of likely candidates, I'd say that's kind of almost a wasted skill. […] My perspective is that in private industry, the most valuable skills would be personnel management conceptualization, instrumentation, and data management and analysis. So, the sort of the foundation of starting and conducting a research project without actually sharing the results in the same way, right?* (DS #5, Recent Graduate, Service focused career [Academia], Lines 95-97).

Many participants often did not explicitly mention technical skills when asked what was important for their future careers. However, their responses to other questions and the high frequency of the technical skills code revealed that technical skills were important and necessary for their intended careers. The omitting of technical skills when directly questioned was interpreted as an implicit assumption that these skills were important and did not need to be mentioned. Communication skills, on the other hand, were explicitly mentioned by all participants in great detail and description.

Participants' descriptions of communication skills were contextual and dependent on what type of career they were pursuing. For academic career seeking participants, communication was an important part of their career function related to research and teaching requirements. For example, when asked what skills were important to their chosen career, one participant remarked:

> *I think writing is a big one. Anything in academia is full of writing. You have to write grants, you have to write syllabi, you have to write your supplementary notes for your lectures if you're gonna give those out to your students and you have to write everything for your tenure review process, like write letters of recommendation for students. So, I feel like that's probably one of the biggest ones.* (DS #4, Entry Phase, Teaching focused career [Academia], Line 77).

Another participant considering academic employment succinctly responded to that same question by saying, "Writing papers." (DS #5, Recent Graduate, Service focused career [Academia], Line 93). They went on to say that these communications skills specific to academia would not benefit them as much if they went into industry and then described how industry requires a different sort of written communication (i.e., technical reports) and that, as someone without a background in engineering before the Ph.D., they never learned how to write these reports. Communication skills were also important to participants seeking or considering non-academic positions. When directly prompted if communication skills were important to their chosen career, one participant seeking a research focused career in government stated:

> *Yeah. I mean, imagine working in any government entity, you're communicating with many other people, whether they're within the office or outside stakeholders, or interested parties. So, yeah. I think having that relationship with people existing now, with people who I may work with in the future, and then also being*

able to communicate science with other people outside of the research realm, I think is very important. (DS #6, Integration Phase, Research focused career [Government], Line 75).

Participants considering a variety of careers particularly focused on the importance of communication skills of all types. One participant considering a variety of careers stated:

Well, okay, so communication is going to be a big deal, you know, whether I go either route. Because publications would be part of it. And also, writing like grant proposals also would be part of it. And also, communicating with other people too. And actually, in both of kind of the careers that I'm leaning...that I'm going in between, I think outreach is a big deal too. For most of the companies, and universities, and things, outreach is a big part of it. So, communication is a big deal, I think. (DS #7, Integration Phase, Research focused career [Academia and Government], Line 125).

To further illustrate that multiple forms of communication is important for different careers, another participant remarked how communication skills as an engineer gave the individual an advantage in being hired. They stated:

Yeah. Yeah. So, I think that in engineering in general, if you are an engineer who is capable of engineering and is capable of communicating, you're gold, you're pure gold. Because you ended up with so many engineers.... I mean, we're all, some level of nerdy. I mean, some of us are just able to interact with people who are less nerdy better than others. And so, I think that's a huge skill, that soft skill is something that's really valuable, especially in a job search because if you have those soft skills, you can exude the confidence that you need to get hired. I think that, you know, going through the job interview processes, I think that if you're able to have confidence and comfortably discuss what you've done and why...basically tell them why you're perfect for their company, then I think that, you know, that's really valuable, and specifically the job, like, the hiring process. (DS #8, Integration Phase, Research focused career [Various] Line 97).

Skills like communication were versatile and could apply to all types of fields. Other versatile skills were working independently and critical and analytical thinking. One participant brought up how skills like time management (i.e., working independently) were more important than technical skills. When discussing important skills for their chosen career they said:

> *[…] and also, time management would be a big deal. Especially if I go academia route. Time management will be a big deal. And independent work in both those places [academia and government] I think will be big. And then, you know, one with like technical skills as well. Which I'm not really, I don't know. I feel like the technical skills kind of come with the education. Right? But it's up to how you handle the education that helps you develop these other skills. And I think that they're maybe more important than the technical skills. […] Because you can have all the technical skills you want, but if you can't manage your time, you're not going to get anything done, you know? And also, I do think employers like to see...and it's harder to sell those things. Right? But I do think they like to see that you can manage time and that you can communicate well, things like that.* (DS #7, Integration Phase, Research focused career [Academia and Government], Lines 126-128).

While participants displayed an implicit assumption that the technical skills they acquired during their Ph.D. were obvious to employers, they also emphasized that it was important to convince employers that they had versatile skills like working independently. Another participant reflected on the importance of versatile skills like critical and analytical thinking and problem solving because “engineers are called upon to solve problems.” (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 73). One participant first began listing the skills most important for their chosen career (i.e., academia) and initially focused on teaching and technical skills. Then, they paused and followed with this statement:

> *I just thought of something. One skill though that I think is most important, I think the most important now that I think about it little more, the soft skills that I've gained, communications, social skills, writing, things of that nature, organization, I think those are probably the ones that will benefit me in any career that I go into. So those are probably the most important.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 101).

One type of skill that was uniquely important to participants seeking academic careers was teaching skills. While teaching skills were coded throughout participant interviews, when directly asked what was important for their chosen career all teaching-focused participants seeking academic careers mentioned teaching. When taking the total number of teaching skills codes and averaging by the participants' preferred career function, teaching focused participants were far more likely to mention teaching skills than research and other types of career functions. Additionally, several skills emerged as more salient to research-focused careers such as working independently, critical and analytical thinking, and securing funding (e.g., grant writing). Skills especially important to service and other types of career functions were technical, organizational culture and ethics, and economic and commercial skills. Skill code averages for all skills sorted by career function is provided in Table 4-5. While there are disciplinary differences in the types of skills mentioned throughout participants interviews, these were not explored in-depth and attributed to individual preferences and experiences.

Table 4-5. Average number of skill codes per participant.

Skill Type	Career Function		
	Research	Teaching	Other
Average # of Skill Codes per Participant	25	24	32
Technical	5	6	8
Communication	6	4	5
Teaching	2	6	5
Working independently	5	2	0
Problem solving	2	1	2
Critical and analytical thinking	2	0	4
Organizational Culture and Ethics	1	2	3
Leadership	0	2	3
Securing Funding	2	1	1
Interpersonal	0	0	1
Teamwork and Collaboration	1	0	1
Economic and Commercial	0	0	1

4.1.2.3 Restricted Skill Development

After listing the skills they had developed during their doctoral program and what skills were important to their intended future career, participants were asked what skills they had not yet had enough time to develop. Responses were varied considering the range of experience participants had and their intended career path. Recent graduates and doctoral candidates brought up technical and especially teaching skills while participants who were still in the integration phase mentioned skills such as time management, communication, and teamwork. For example, one participant early in the integration phase (i.e., second semester of their doctoral program) wanted to be more efficient with their time when asked about what skills they did not have enough opportunities to develop. They stated:

> *I mean, I haven't had, like, a lot of time. I've been buried and doing data analysis that I haven't had a lot of time to do too much writing or even literature review. And so, I would like to be able to be better at organizing my time, or be more efficient at certain tasks, so that I can supplement my day to day with some literature review. And it's not just, like, the same data analysis, and where I don't feel like I have time to do any literature review. So, time management, it would be probably the one thing I need to work on better.* (DS #6, Integration Phase, Research focused career [Government], Line 81).

Another participant who only had one more semester of coursework reflected on the skills that they had already developed (i.e., working independently, communication) and thought they needed to further refine those skills. They said:

> *So, I think I've made a lot of progress in some places, but I feel like I need to make more progress in all kind of the same skills, like time management. Same with communication. And you learn some skills through experience. So, like publishing and going through like the peer review process, things like that. I haven't done that much. So, I haven't learned like how to write for that. That'll come with more time, I think I'm doing it more. I'm early on in the Ph.D.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 111).

The one participant who had just begun their doctoral program only listed communication (i.e., presentations) and teaching skills. This participant expressed confidence that they would have the opportunity to develop these skills as they progressed throughout the program but expressed apprehension for teaching a class at their current experience. They said:

> *I know it's my first semester and I am not ready to take on a class so please don't suggest it to someone. But I think that in the future, I'd like to teach maybe an undergrad class and make sure I do like it before I start applying for jobs in it. And I think that, I don't know, it's valuable for all Ph.D. students. Even if you're looking into going into research, you'll still have to teach at least one class. There are very few professors who get away with not teaching anything. And I think we do a poor job of preparing grad students in general to become teachers.* (DS #4, Entry Phase, Teaching focused career [Academia], Line 79).

Teaching was the skill that participants expressed the most frustration over not being able to develop, especially doctoral candidates and recent graduates interested in academic careers. While participants were engaged in research activities as part of their degree requirements (e.g., dissertation) or employment (e.g., research assistantship), they had to push for opportunities to develop their teaching skills. For example, one doctoral candidate remarked:

> *Students aren't given enough opportunities to teach. I didn't mention this earlier, but that's also something I'd like to do in my courses. I'd like to implement student, like, peer teaching. I'd like them to teach each other because that's when I learned the best. I took this class that I'm teaching now three years ago, and I did well in it, and I understood most things but not nearly as well as I understand it now because having to teach it, like you have to delve really deep into it to learn it. So, I wish there'd been more opportunity for me to teach. Research is good. I mean, I think just that's the emphasis of most Ph.D.s, right? That's why we get a Ph.D., you're researching something. The Ph.D. is training you to think deeper. So, I think Ph.D.s typically do a good job at training people with regard to the skills necessary for research, but not to other facets of life.* (DS #1, Candidacy Phase, Teaching focused career [Academia] Line 103).

One recent graduate reflected that they wanted to further improve their teaching skills after reflecting on their postgraduate experience with teaching a class. They said:

> *I wanna be better at teaching, you know, that was a good... And I figured it would be, but it was a good, you know, slap in the face teaching and trying to motivate students. […] So, I'd like to be a better educator. I'd like to be a better teacher. That's part of the interest in being an adjunct. And I think that's a very, very, very different skill set than being a good researcher and being a Ph.D. Teaching is very, very different. And I think, you know, any skill you learn, I think you can use to benefit any other skill you are learning. I don't think they're... It's not like they don't overlap, but you're definitely not being taught to be a good teacher in front of a classroom. Like in that learning classroom, especially for Ph.D., like I've heard they talk about classroom management skills for education majors at the bachelor's degree level. That's not something we talk about at the Ph.D. level.* (DS #3, Recent Graduate, Engineering focused career [Various], Line 91-92).

Another recent graduate also expressed their frustration about not having as many opportunities to develop teaching skills. They said:

> *I would say that the biggest hole in my experience as a person who wants to go into academia is teaching. I think that oftentimes in academic positions, it's kind of just assumed that if you know the material, you can teach it, but that's obviously not true. So, I'd say that's the biggest hole and skillset development that I've had in this program. I have taken the opportunity to guest lecturer in courses, and I've TA'd for labs to try to build up that experience. It's not necessary. It's not mandatory. It's not a common set of experiences that folks in a Ph.D. program receive, which I think is a shame*. (DS #5, Recent Graduate, Service focused career [Academia], Line 107).

Two participants expressed they needed to further develop their research skills. One described apprehension over being ready for the dissertation process and finishing within their desired time frame. The second expressed a desire to be better at various research methods as they contemplated their new status as a Ph.D. and entry into the field. They said:

> *And I will say I am... I mean, I'm not as good at anything as I'd like to be; engineering, research, you know, qualitative research. So, I'd love to know more about qualitative research methods. There are methods I am interested in like narrative research. I haven't done any of that. I think it sounds fascinating. But even the ones I have done, like I've done some grounded theory stuff and I still just feel like I am just a noob, right? I've done a two or three of those studies and every time it's like, "Man, this could have been done better. And I think that's part of the idea of the Ph.D., is you're getting, you know, you're trying to refine what you're doing. And so, a lot of, I think for professors, people who are known as, you know, great thinkers in the field, they have refined their methods so they're really good at them and they understand the implications of all the little decisions they make in their methods. And in their design, before they even, you know, actually do the data collection, they have designed things to work out well in the end*. (DS #3, Recent Graduate, Engineering focused career [Various], Line 88).

4.1.2.4 Purposeful Skill Development

As participants have stated, they have had many structured opportunities to develop research skills through their dissertation or their research assistantships. Along with these structured opportunities, participants expressed that they had the support of a research advisor or other faculty who is guiding them through the development of their research skills. Other skills such as teaching required participants to go above and beyond to find opportunities within and outside of their degree program. For example, one participant altered their program of study several times to take classes on how to teach engineering alongside their program-specific course requirements. They expressed a desire for teaching skills to be incorporated into their doctoral degree program by saying:

> *But I think [doctoral students] should at least teach, or at least be required to take Teaching Assessment and Evaluation [an Engineering Education course], or whatever that course is named. That's phenomenal. So anyway, but I wish that I had known of the availability of these courses from the get-go and been able to*

> *put them on my plan of study. But I've had like five corrections, four corrections to my plan of study because I just wasn't aware. I didn't know what classes I wanted to take. I don't know. I just wish that I had been more informed on that kind of stuff earlier.* (DS #1, Candidacy Phase, Teaching focused career [Academia] Line 67).

The participant also had to intentionally seek out an opportunity to teach a graduate level class within their department but would have preferred to teach an undergraduate course because it would be more applicable to their future career. When asked how the university could further support their career development needs, they reflected on the university's role in ensuring its doctoral students know how to teach. They said:

> *The university would help more if they required Ph.D. students to take...and also new applicants, like people that are going to work here, new hires, I think a new professor should be required to take a teaching course if they haven't taken one before. I think Ph.D. students should be required to have that as well.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 145).

Engineering education participants, who had opportunities to develop teaching skills during their Ph.D. programs through coursework, reflected that teaching skills could not only be taught through coursework, but also required hands-on experience to develop. They remarked on how this hands-on teaching experience was also built into their program's structured requirements. However, when skill development opportunities were not built into the program's structure or degree requirements, participants also expressed concerns over the utility of pursuing such resources especially when they had limited time.

In general, participants described faculty research supervisors as being passively supportive of them pursuing skill development opportunities not directly related to research or degree requirements. They would not oppose a student who wanted to seek out these opportunities, but the student had to first ensure they were meeting all of their typical programmatic and assistantship requirements first. Another participant described several opportunities to gain teaching skills outside of their program including the Graduate Training Series (GrTS) that the School of Graduate Studies puts on, attending a seminar on how to teach undergraduate students on a Saturday, and an opportunity to develop curriculum for the Intensive English Institute. When reflecting on these opportunities they stated, “But again, that [opportunity] would not have happened if not for particular set of circumstances and personal connections and was not supported by the university. They [research advisor] didn't say no [to pursuing the opportunity], but they also didn't facilitate.” (DS #5, Recent Graduate, Service focused career [Academia], Line 109). However, this participant and others felt that some opportunities were mismatched to the career they wanted to pursue. When pressed further about where they would look for opportunities for career development, DS #5 reflected on how their department and advisor reacted to non-research related skill development opportunity. The participant and I had the following exchange:

> *DS #5: I've been mostly focused on research and haven't taken a whole lot of time to work on professional development. There's not a whole lot of push for that, I would say.*
> *Laura: Push from who?*
> *DS #5: From my department, from my advisor. They're very supportive, but it's not like, "Oh, you should do this so that you're more employable," or, "You should do this so that you’re a better teacher." They're really focused on, "You should do this since you can get publications so that you can demonstrate that you're a good*

researcher. And that's enough, that will speak for itself. (DS #5, Recent Graduate, Service focused career [Academia], Lines 138-140)

4.1.3. Theme #3: Time

The theme of time emerged as an integral aspect of all phases of doctoral student development for participants and affected how they approached future employment. As students, participants were caught between the *present* demands of their program or research and the *future* career they were working towards. As doctoral students, considerations of the present and future resulted in perceiving and experiencing time in two ways: objectively and subjectively. Objective time (i.e., present time) is an absolute way of measuring time (e.g., minutes, days, months) with a single way of interpretation (Eldor et al., 2017; Fried et al., 2007; Fried & Slowik, 2004). Participants had to meet deadlines for classes, degree progress, and for research tasks such as conference submission deadlines. At the same time, they had to balance their personal lives which could include significant others and children. Participants were put in a ‘survival’ mode where they concentrated on meeting their most immediate deadlines typically set by the university, their research supervisors, or other organizations. Experiencing time objectively required students to develop tactics around time management and prioritization and, in some cases, to research and apply to jobs or opportunities in the moment. This objective view of time also manifested in participants placing a high emphasis and importance on work-life balance in their current programs and in considering their future career. **Subjective time** (i.e., future time) is a relativistic way of perceiving and experiencing time that is dependent on a participant’s contextual circumstances (Eldor et al., 2017; Fried & Slowik, 2004; Fried et al., 2007). When a participant experiences time subjectively, they are living in the present moment while also recollecting the past and anticipating the future. When working towards their Ph.D., participants simultaneously had to manage and engage in tasks that could result in attaining employment (e.g., applying for jobs, developing teaching skills). Issues of ‘timing’ were critical in their decision to pursue a Ph.D., how they managed their degree and assistantship requirements, and in future career considerations. Throughout their interviews, participants revealed how they intentionally tried to save time and struggled not to waste it. Because their future employment was sometimes not as pressing as their current tasks, participants constantly had to balance costs and benefits in the short and long term.

Finally, some participants revealed tactics on how to balance these two ways of experiencing time. This approach to managing alternative perceptions of time was labeled as Time Adaptive Tactics (TATs) because it required a tactical compromise of both subjective and objective views of time. Participants utilized three primary TATs: (1) *Flexibility* in what types of opportunities they pursued or what careers they would consider; (2) *Networking* by leveraging their current contacts within their departments or in professional societies to reveal what skills they needed to develop and to find career opportunities; and (3) *Using career resources*, especially those that allowed alternative ways of accessing them in ways that were independent of time and/or location.

4.1.3.1 Objective Time

Objective time is focused on the present. It is an absolute measurement of time, which is continuous and advances linearly (i.e., past to present to future). Objective Time is measured in definable units and is experienced the same by individuals (e.g., seconds, days, months, etc.). Since objective time is measurable, it can be controlled and allocated for efficiency and optimizing performance (Eldor et al., 2017). Participants experiencing or perceiving objective time are, at the moment, focused on their *present* situation over their future career even if they were aware that this allocation of time would potentially hurt their chances of future employment. The four most salient codes for Objective Time are provided in this section. These are made up of three tactics: (a) time management and priorities; (b) survival; (c) present job search (i.e., actively seeking knowledge about and applying to jobs), and one overarching objective:(d) achieving work-life balance both as a student and in their future careers.

Time Management and Priorities

Participants experiencing Objective Time were fixated on managing their time. As described in the previous theme of Engineering Doctoral Skill Development, working independently (which requires time management) was brought up frequently by the majority of participants. Time management was salient for all participants, but it was especially important for the participants who had extra roles and responsibilities. For example, one participant with children described some of the skills they had developed as a doctoral student by saying:

> *Other skills, I think I'm doing decently on time management, but I think I'm forced to do that just because of kids and trying to get a Ph.D. at the same time. But that has been definitely a big change from like my masters say, so my master's, I could work whenever, however, on whatever, and now it's really, I need to figure out what I need to focus on each day and just work on that. So that's probably been the biggest thing just throughout this entire program that I've...the skill I guess I really worked on.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 88).

Another participant with children reflected on the skills they had developed so far in their program and stated:

> *And, it's really being in school for this long, and dealing with classes, and research, and things like that, I think I've learned how to balance my time better between things to do here. And also, between home and school. And how to prioritize. You know, if I got a whole bunch of tasks, how to determine which task is most important and when to do it. So, I think time management, prioritizing, and balance of the time has also been something I've gained.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 114).

These time management skills were inseparable from the doctoral student experience of this participant. Through the time-intensive requirements of their program (e.g., classes, research), this participant has to learn how to manage their time both as a student and at home. When directly asked if coursework and research opportunities had allowed them to develop these time management skills, they responded:

> *Yes, definitely. Yeah. Not like in a formal sense, but like having both research and coursework at the same time, kind of forces you to learn how to do it. Or having a lot of classes forces you to figure out how to do all the classes. So, it has really helped. And it helps too that they're like, again, the categories, right, it helps that they're like blocks. It's like a class, you have all the tests in that class. And then another class, you have all the tasks in that class. And I break up my research sometimes into blocks to like between like writing, or like writing code or reading literature, things like that. And I feel like the class and the research kind of lend themselves to doing that a little bit easier. So, it kind of helps to figure out how to organize it.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 120-121).

Managing time and priorities also meant not taking opportunities for some participants. When asked about challenges they anticipated in finding a job, one participant lamented that they had not pursued as many opportunities to publish despite its importance for their future career. They stated:

> *Since I do want tenure-track, one of the biggest things just for me personally is lack of journal articles. So, and I don't...I haven't had an opportunity—which could be myself—I haven't created the opportunities, but I also haven't been aware of all the opportunities to create journal articles, conference papers. And so definitely personally I might see these lacking in that aspect, and so I see how that can affect my job search significantly, especially at that tenure-track level, which is why I am also considering postdoc positions which I don't think I've mentioned yet. But obviously, I think you can tell, I'm more interested in a faculty position first, but I'm not against a postdoc position just because I am lacking in that peer review article section on my CV.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 84).

Survival

While participants were seeking opportunities to develop the skills, they perceived they needed for their future careers, they often had to make choices on how to allocate their limited time. One tactic participants utilized was to focus on survival (i.e., focusing exclusively on the tasks that are most pressing instead of seeking out skill development for a future career). Survival involved completing tasks that were most pressing or allocating time or energy towards the most immediate deadline. These tasks typically resulted in focusing on tasks related to degree progress or being employed as a research assistant. One participant, when describing their long-term career aspects, brought up their current experience of teaching a graduate class and how they had to use lecture as a teaching method in order to save time. They stated:

> *In terms of teaching, my goals, I have a great passion for teaching and I really don't love lecture. I don't like being in a class with lecture most of the time. It's just boring. If I sit too long without interacting, if there's no active learning going on, it's hard to stay awake forever. So, I don't like that as a teacher. This*

> *semester, I'm teaching a graduate course [...], it's very fun. I love it, which is a good sign because that's what I want to. But I'm using a lecture mostly because I'm just trying to survive with doing teaching and research, like tenure is going to be a terrible, terrible, terrible process. But I am focusing right now and just surviving. So, I'm using lecture notes. I borrowed the lecture notes from my professor actually who taught it the last few years. He teaches it usually. I borrowed his notes; I've been rewriting them as I go so I make sure they're accurate and they are up to date. But I hardly have time to do what I wanna do. So, I've been living by lecture and it's not the most effective way to learn for students.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 75).

This survival tactic even extended to their anticipation of a future career as a tenure-track faculty. The participant expressed apprehension over whether teaching with the pedagogical methods they preferred was possible. When asked if their long-term goal to use active-learning instead of lecture in their classrooms was possible before achieving tenure, the participant responded that it depended on their teaching-research-service role statement and duties for promotion and tenure, and then remarked:

> *I'm gonna be honest. Recently, I've had concerns about that, will I be able to do that before tenure or after? I'm thinking, right now, after. If it's anything like this semester, at least I'm not gonna be able to start doing that for the first year because it is pure survival. If I'm getting a teaching position where I'm teaching four classes in a semester...Right now, I'm only teaching one graduate class and three undergraduate labs. And so, those take a lot of time already. If I have to teach four classes in a semester though, I don't know how I'm gonna keep my head above water. I just don't.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 82).

Participants in this survival mode focused on current degree requirements over longer-term career development or considerations, even when tasks associated with the future (i.e., a job search) were becoming a more pressing need. One participant brought up how they did not seek out or utilize opportunities to further develop their skills not because they did not exist within their program, but because they required extra time. They stated:

> *[…] so, the opportunities are there had I wanted to take it. But since I had already had teaching experience and family commitments, I just didn't take those opportunities. So yes, I could have developed those skills more in my Ph.D. program, I just didn't take this...take that particular opportunity from the opportunities I did take which is basically just coursework. I don't feel like those fully helped a lot.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 95).

Present Job Search

Participants at all stages of their program or phase of doctoral student development were specifically asked about their job search and what they were doing in the present. Participants' responses varied from not searching at all to actively searching and applying to jobs. Those participants engaged in a job search of any kind utilized the tactic of actively seeking knowledge about jobs (Table C-5). A few participants went beyond seeking knowledge to applying that knowledge to shape the professional development activities they engaged in and even actively applying to jobs (Table C-5). A summary of participants' current job search status is provided in Table 4-6. Participants in all phases of doctoral student development were searching in some capacity. Only two out of nine participants were not passively or actively searching for a job.

Table 4-6. Job search process of participants by development phase.

Participant	Phase Description	Job Search
Phase I: Entry Admission and Orientation		
Participant	**Phase Description**	**Job Search**
DS #4	First semester of courses	Actively searching
Phase II: Integration Coursework and Examinations		
Participant	**Phase Description**	**Job Search**
DS #6	Second semester of courses	Not searching
DS #7	Coursework and research	Passively searching
DS #9	Coursework and research	Not searching
DS #8	Coursework and research	Actively searching
Phase III: Candidacy and Recent Graduates Dissertation and Job search		
Participant	**Phase Description**	**Job Search**
DS #2	Beginning dissertation	Actively searching and applying
DS #1	Working on dissertation	Actively searching and applying
DS #3	Defended dissertation	Employed and passively searching
DS #5	Graduated	Actively searching and applying

In general, participants who were doctoral candidates and recent graduates were actively searching for and applying to jobs while participants in the integration phase were either looking or not looking at jobs. The one participant in the entry phase described actively searching for both academic and industry jobs. When asked about industry jobs in light of their stated preference for working in academia, they responded:

> *Mostly because it was sort of offered. One of my friends is the head of HR there and she's telling me that 'When you graduate, come talk to me. We'll find you a job in Albuquerque. You'd be a great fit.' And then I worry that like getting a Ph.D. was a mistake and maybe I would be a great fit, maybe I should do industry. But then I remembered, I don't wanna work in industry.* (DS #4, Entry Phase, Teaching focused career [Academia], Line 68).

In contrast, one participant who was in their second semester of classes (i.e., integration phase) when asked what they were doing for a job search stated:

> *I'm not doing anything now. I mean, before I started my Ph.D., I was looking at government jobs and using like USA Jobs, and Indeed, and the typical, like, search engine job finders. But currently, I'm not looking. I'm not...yeah, I don't ever check any sort of job boards or anything like that.* (DS #6, Integration Phase, Research focused career [Government], Line 67).

The other participants in the Integration phase had various responses to what they were doing for a job search. One participant described how they passively searched for jobs and went to career fairs to discover potential companies to work for. Another participant took this idea further and was using this job search to discover what they wanted to do with their Ph.D. They said:

> *So, I'm passively searching, I guess. Like I have job agents that weekly will pull up jobs. Because part of the reason for that is because I'm still not exactly sure what I want to do. Like I said, it's pretty fluid. And so, I'm trying to learn more about the jobs, I guess. And also see like what's something I could get. Because I've had ideas before for a job that I'd like, but nobody hires anybody for that job, you know. So, yeah, I guess, I'm kind of trying to keep all my doors open. So, I look now and then, but I wouldn't probably...I don't think I'd take a job at right now, you know. Or, you know, apply. But I definitely studied how to apply it and figure it out because I feel like it's beneficial for shaping what I do know. And*

> *also being prepared to get a job later on.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 100).

Despite the advantages this participant describes in searching for jobs at these earlier stages of their program, they mentioned a serious drawback earlier in their interview. The participant was tempted to take their master's degree and find a job instead of continuing with their Ph.D. They said:

> *I've reached the point that I finished all the coursework that I need for my master's. So technically, at any time I could stop and get my masters and go get a job, which makes it so hard. I try to stay away from job boards for that because I'll find the job and be like, "I would love that job. Like, give me that job, and they only need a master's degree. I could stop right now and get a job." And so that's definitely the biggest downside is knowing. Because now I have that confidence, like, you know, going through my resume and CV and things like that and looking at jobs, I'm like, "Oh yeah, I check that off in like four different ways," and like, "I would be all over that job." But also realizing that I still have two more years left and that's probably like that. And, I guess, I kind of, you know, guessed that this what happened to me, and I think it happens to every doctoral student as the years go on and we're still here.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 65).

Participants in the candidacy phase and recent graduates were balancing both dissertation requirements and their immediate job search. This balancing act became complicated when they had to take an employer's timeline into consideration. This was particularly salient for participants seeking academic careers where the Ph.D. degree is required. One candidate described how there were searching for jobs while still enrolled in their Ph.D. program and applied to several even though they were not close to graduating. They described one of the job descriptions they applied for as "ideal", but the position required a Ph.D. and employers wanted the candidate to start soon. They described how it was possible for them to finish their Ph.D. and the job was a good incentive to. However, they said:

> *[…] but I never heard back from them and I didn't really want to pretty much kill myself to try to get my Ph.D. wrapped up if...I kind of wanted the extra year, like so that would've been the end of my third year finishing my Ph.D., which was really fast as possible. But I still thought I wanted this last year of experience before I got a job. And so, if I didn't hear back from them, I just assumed I didn't get it. And so, I didn't wanna rush things if I didn't need to. And then they called me back in April and said, "You're in our top 10. We're just wondering if you're on track to graduate still." And it's like...I am not, but thanks*. (DS #1, Candidacy Phase, Teaching focused career [Academia], Lines 88-90).

Another consideration for academic career seeking participants was the time it took to publish journal articles, which they described as a major factor in being hired. This time it took to publish was in stark contrast and sometimes opposition to the time a student had before they started looking for a job. The other academic-career seeking candidates or recent graduates also expressed their apprehension over their lack of publications and would even seek out less ideal career options for the opportunity to gain more publications. When asked what they wished they knew before deciding to enroll in their program, one candidate brought up this reality. They said:

> *I would have pushed harder from the beginning to get publications out because I didn't realize how long it takes to publish. It's absurd. In our field especially […] I just barely got one published that we submitted like 10 months ago. I submitted it in December and it just got published this week. So, like 10 months and there's other journals that are notoriously worse than that. There's some that are quicker, but not much quicker in my field. So anyway, I only have a couple journal articles that are published now and it's not because we don't have articles prepared. It's because they take so long to publish and so, I wish I'd known that, and I would*

> *have started publishing earlier*. (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 59).

Work-life Balance

Another aspect of objective time participants showed in their responses was their preference for a stable work-life balance. Work-life balance is the allocation of time between working time and personal time in a way that the individual perceives positively or balanced in a way that results in a healthy, enjoyable life (Thompson & Beauvais, 2000; Watts, 2009). Work-life balance time allocations are unique to each individual and are determined by a fixed number of hours in a day. For this study, seven out of the nine participants in this study mentioned work-life balance as important to them for employment quality. For example, one participant stated:

> *Yeah. I think it'd be really nice to have some sort of work-life balance. Well, I mean that's always the goal, right? I mean there's always some sort of work-life balance that you wanna achieve. And so, I think that, you know, having a job that's willing to...or finding a job that meets that work-life balance, whatever that may be for the individual, is very key. And for me, I think that that's very important*. (DS #8, Integration Phase, Research focused career [Various], Line 105).

Of these participants, five mentioned having children in their interviews without being prompted and put a high value on having a career that allowed them time with their family. For example, when asked what was most important in terms of employment quality, one participant stated:

> *Most important? I would say the biggest factor...I like work, I really like work. I think I'm good at it. I'm a hard worker and diligent. I'll do well. I'll do pretty well, I think, anywhere that I end up. But the thing that worries me is although I enjoy*

> *work, there's more important things in the world than work. So, the biggest thing is I would really like a job that allows me sufficient time with my family. That's the biggest thing. Balancing work and family*. (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 113).

Another participant with children stated that work-life balance was important to them and how future employment had to take their spouse into account. They stated:

> *Work-life balance, that is probably number one just because I do already have a family. Location is also big, just because I have a significant other who also has to work, so he has to be able to find a job. And I am interested in places that have good opportunities for children to be a part of, and I have young kids and so that interests me. So yeah, work-life balance and location are pretty big, but probably the third thing is career trajectory*. (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 106).

Despite the fixation on work-life balance, some participants knew they had to temper their expectations. One participant stated:

> *So, for me, work-life balance is extremely important, but you know, it's not like I expect to be going on vacations to Hawaii with my family on a regular basis, like... But, you know, if you're putting in 60 hours a week, that's really starting to impact things. You know, you can do it occasionally, but all the time this is rough, especially for one job, right? Like I was doing 60-hour weeks for a while, but I was Ph.D. and real job and that was hard. But to do that for one job, it gets old if you have to do it for more than like a week in a row*. (DS #3, Recent Graduate, Engineering focused career [Various], Line 102).

Only a few participants did not explicitly list work-life balance as an important employment characteristic when asked. One participant later added that while work-life balance was important in the end, they did not think it was reasonable to expect in a tenure-track academic position. Even when prompted, these participants did not bring up work-life balance as important for future employment quality:

> *I mean, work-life balance was always important. But I think a lot of that is not very...I don't think it's feasible from what I've seen to have a healthy work-life balance as an untenured faculty member. So, I think hunting for a position that had good work-life balance early on, is you'd look forever. That being said, that is important to me in the long-term. Like, I understand that there's a period of hellacious work for six, eight years to get tenured. [...] I guess one thing that is important to me is finding a department where the department chair is also aware of the strain that's put on new faculty, someone who's willing to deflect, say, service duties from a junior faculty member until they are established enough to actually be able to divide their time.* (DS #5, Recent Graduate, Service focused career [Academia], Line 124).

4.1.3.2 Subjective Time

Subjective time is focused on the future and is a subjective understanding and experience of time. Its units are not measured by the same by every individual. It is relational, meaning that it is relative to the surrounding context. This includes cultural expectations and norms of time (e.g., early being on time, being expected to show up much later to events, etc.) (Fried et al., 2007). Situational influences have an effect on an individual's experience of time including repetition, predictability, and emotional impact (Eldor et al., 2017). Individuals remember the past, perceive the present, and anticipate the future. They are not simply living in the present, but constantly navigating between past memories and their future expectations.

The three most salient codes for Subjective Time are provided in this section. These are: (a) timing; (b) short term vs. long term; and (c) efficiency and optimization. Participants experienced and described time subjectively as they navigated their doctoral student experience. Enrolling in a Ph.D. was often based upon good ‘timing’ where the decision to enroll was based on an accounting of the long-term cost benefits of dedicating four or more years of their working life to attain their degree. In considering their situation and balancing their respective roles and requirements, participants were preoccupied with saving and wasting time in order to be efficient with and optimize their time. They were conflicted between activities in the short term versus those in the long term, frequently bringing up examples where there was ‘never enough time’ or if they had ‘time setbacks’ in their progress because they pursued professional development over their more immediate degree requirements.

Timing

All of the participants were asked to tell the story of how they decided to enroll in their doctoral program and what considerations influenced their decisions. While the participants came from different backgrounds and had different future career goals, they all expressed the importance of timing had in their decision. Good timing was primarily actualized in the presence of funding (e.g., research supervisor funding, fellowships), but could also arise out of transitions from other degrees or careers. The timing of fellowship and research advisor grants was important for several of the participants in the study. For example, one participant recounted their decision to pursue a Ph.D. They said:

> *I was not going to do a Ph.D. It's kind of an accident. […] Halfway through my master's, my adviser came in though and he said, "There's this fellowship I'd like to submit your name for." And I said, "Don't waste your time. I'm not doing a Ph.D. I've been here too long." And he said, "Well, don't say no yet. Just think about it." And so I said, "All right. I won't say no yet, but I'm not going to do it." And so, I went home, and I started thinking about it. And I didn't really wanna do a Ph.D., but I just...it's like when you have that feeling of something you should do, but you don't wanna do it. I had that feeling. And so, I decided that if I got the fellowship, I would do it. And so, I got the fellowship and here I am. I don't regret it at all. I'm really grateful that I chose to do that.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 44).

Another participant described how they made a connection with their future research advisor during an undergraduate research opportunity that persisted throughout their master's degree. They continued:

> *And when she got a grant funded that had a Ph.D. opening, she contacted me knowing that I had done my master's along similar lines to really the opportunity presented itself. And at the time I was just finishing my master's when she asked me if I wanted to do a Ph.D., did not have another job lined up, and was not terribly excited about what I had been seeing in the field. And so, doing a Ph.D. at that time gave me some direction*. (DS #5, Recent Graduate, Service focused career [Academia], Line 44).

Another participant mentioned that they were about to graduate with a bachelor's degree when the department invited them to a graduate school information session because they were within the top percentage for GPA in their graduating class. While initially only considering a master's degree, they began to consider a Ph.D. as they researched their options. They stated:

> *You know, if a master's degree gets me this much, a Ph.D. would get me even more, that kind of the idea with that. And so, then I kind of thought about like, okay, I'll do a master's degree and then maybe I'll see where I'm at and go onto a Ph.D. after that. But then I was invited to apply for [a fellowship] here. And so, I applied for that and ended up receiving that. And so, when it came down to my decision and I decided to stay [here], I decided to jump straight into my Ph.D. so I could receive the fellowship. And so now I'm doing a concurrent Masters-Ph.D. program and getting paid for it. So that worked out really well. So, I mean that's the reason why I'm in a Ph.D. right now as opposed to having...or as far along as a Ph.D. as I was. It was my plan to do a master's degree and then kind of do an evaluation of it and then pursue a Ph.D. But it was too good of an offer to pass up to be able to do four years of paid, really good pay and everything, and be able to get the master's and Ph.D. in those four years instead of maybe a five or six-year program that would have required me to pay some of my master's degree. So*

> *yeah. So that was my story of why I'm here.* (DS #8, Integration Phase, Research focused career [Various], Line 51).

This participant not only had a funding opportunity lined up, but was also at a critical transition point in evaluating their future career path (i.e., graduating with a bachelor's degree.). Another participant described similar ideal timing in pursuing their Ph.D. They stated:

> *So, like I said, I knew I wanted a Ph.D. at some point. I thought I would eventually be working and doing it at the same time. And so, at this point, I had the opportunity to just do it full time. Well, I wasn't fully...I wasn't gonna do it full time just because of other circumstances, but I wasn't gonna be working at the same time. But then I had that...so I had the opportunity to do it, and then when I had the opportunity to actually do it full time just because of the way that the program here allows you to work, it all just kind of clicked.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 63).

Another was about to graduate with a master's degree and was looking to continue researching, and the last described looking for a change of location and was alerted to a job posting describing their research assistantship. A participant also mentioned being in a transition between their master's degree and a future career when they were approached by their future advisor to do a Ph.D. They said:

> *It kind of just…like, the right project showed up finally. And I was not... I mean, I'd been kind of thinking about it off and on for, like, several months, for, like, maybe even nearly a year, whenever I was getting close to finishing my master's. And then I took some time off from school and decided not to do a Ph.D. I was, like, looking into doing a Ph.D., and I was going to start one, then I decided not to start one. And then I came back to Logan, and just started working after traveling, and started working in the water lab just with my old advisor. He had some just, like, data management stuff to work on, and then started helping*

> *another advisor who is now my current advisor. And she kept, "Oh, you should do a Ph.D., you should do a Ph.D.." And I was never really into the projects that she had available at the time. But then it was really this specific project got funded, and she was looking for a student, and it was...the study is along the lines of what I want to know and want to learn about. And then just, like, the timing was right for me, basically.* (DS #6, Integration Phase, Research focused career [Government], Line 41).

Timing was also important for candidates and recent graduates searching for a job. Participants in these phases describe how there is a certain timing for industry and especially academic jobs. When asked about their job search process, one candidate stated:

> *So, all the jobs are opening up right now for academia for next year, right? So, I've seen a lot of them come through. I haven't been able to get any applications in yet because I haven't had time to get all my documents in order.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 86).

They then described how they applied for several jobs, but one would require them to graduate as soon as possible (Section 4.1.3.1 Present Job Search). The timing did not align and thus, this student had to pass on being seriously considered for an opportunity they described as an “ideal position” (Line 88). This was also the case for another participant when they were close to graduating. When asked about their job search, a recent graduate stated:

> *It's better than expected. I've had one solid offer from a private consulting firm who's looking for someone to work on a particular project, and then they were offering to onboard me to the company through this project, and then hire fulltime. The timing didn't quite work out because they were looking for someone as I was finishing up my dissertation. But that experience of having someone essentially recruit me was exciting and also affirming that there are jobs out*

> *there, that being said. So, I turned down that opportunity, one, because the location, and two, because the timing wasn't quite right.* (DS #5, Recent Graduate, Service focused career [Academia], Line 83).

Short Term vs. Long Term

As part of the dramaturgical coding process, ‘conflicts’ were coded for each participant using versus coding, which identifies dichotomous or binary terms in direct conflict with each other (Saldaña, 2016). The most frequent conflict coded was ‘short term vs. long term’, which was coded for all nine participants. Short term vs. long term means a participant is experiencing some sort of conflict or struggle in allocating time and energy to tasks that will benefit them more immediately (e.g., coursework) or tasks that will provide benefit in the long term (e.g., professional development). Short-term tasks are more pressing and typically have extrinsic motivation (e.g., grades, research advisor) to complete. Long-term tasks were not immediately dire but could have more profound effects on a participant’s career prospects or employability in their field. For example, participants seeking teaching focused careers pursued non-mandated teaching opportunities through taking extra courses, extracurricular professional development sessions, or volunteering to teach classes to develop skill important to their future career.

The short-term vs. long-term conflict also manifested in the type of research that was pursued for a dissertation. One participant described how this dissertation research topic could be influenced from the very start of the Ph.D. program and affect their future research directions in an academic career. For example, when asked what they wished they knew about the doctoral program before enrolling, one participant stated:

> *What do I wish I knew? I wish I knew more about everyone's research, all the faculties research interests, what their current projects are and what those projects impacts have in the future. Because that was the hardest thing, picking what my research path was and think...trying to think about how that research path is going to help me in the next step in my career, but I'm picking this in my first and second year and just I wish I...I don't know, I wish there was more information on that or I could see the connections more to the future with what I'm trying to do now.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 65).

They further described that one of the barriers that prevented them from being aware of the possible research topics they could explore was time and preconceptions about how graduate programs are run. They said:

> *[…] but it still would have taken me the time to go and ask every single [faculty] and ask them the questions and ask them, where do you see [this research] going, and that type of thing, which I just feel like as a new student, I was intimidated, I wasn't gonna go about doing that. And plus, based on the experience I had in my masters, I thought you were just given a project and you take that project and then you hope that it's really what you wanna do, especially in your career, because your career usually builds off of this. And so that's the impression I was under is that you're...you get what you get, and you go with it.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 69)

One participant described how they initially wanted to research a topic they were genuinely interested in and could connect to a future career. However, as they interacted with their committee and took in their feedback, they became overwhelmed with the work and time required. Instead, they choose to go in another direction "…because we could do it faster. Because I already knew all the literature for it because that's what we've been researching." (DS #3, Recent Graduate, Engineering focused career

[Various], Line 66). Another participant wanted to finish their dissertation quickly. They said:

> *So, I am putting the deadline on myself of getting my dissertation completed in probably a very quick timeline, but I can see how it would be valuable and it would definitely help me develop my skills in research a lot more if I could...if I didn't have such a short timeline.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 97).

Another participant reflected on how a fellowship they received allowed them the freedom to pursue the research fields and topics they were most interested in. When asked what skills they did not have enough opportunities to develop, they responded:

> *That's a good question. I'm not sure. Right now I don't feel like they are necessarily skills that I don't have time...like, I feel like I wish I could...I mean they're research ideas that I have that I wish I could pursue, but I don't have time to necessarily pursue all the research ideas I have, but I think all of them more or less a require the same skill set. And so, I feel like all of, you know, the things that I'm pursuing are helping me with the skill sets that I'm trying to develop. Though I could see potentially how...because of my fellowship, I have the funding to pursue the research fields that I want independently, which is really nice. I could see, though, that perhaps if I had been constrained, I guess, going to the example of the wind tunnel at Purdue, if I had gone there and my funding was to work on the wind tunnel, however my desire to research fundamental aerodynamics, you know, pushed me in a different direction, I could see there being a conflict of I'm spending all my time on this experimental wind tunnel, but I really wish that I could develop more on my skills of designing fundamental models for aerodynamics*. (DS #8, Integration Phase, Research focused career [Various], Line 101).

The short term vs. long term conflict manifested in the process of applying to jobs during candidacy. Candidacy involves both writing the dissertation (which is a more immediate task) and the job search (a longer-term task). Focusing on one or the other required participants to make decisions on allocating time to professional development and applying to jobs compared to the idea of pushing harder to finish the dissertation to meet an employer's timeframe. One candidate reiterated their focus on their dissertation to develop research skills and finish their degree. They said:

> *I feel like having this dissertation requirement that I'm gonna go through in the next year is really going to develop that skill because I have 100% focus on the dissertation, not other commitments like you would have in a career, but I can focus 100% on it and really grow those types of skills.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 90).

In contrast, a participant still in the integration phase when asked what challenges they anticipated in finding a job stated:

> *Time. Job searching and filling out job applications can be time expensive, especially if you're trying to finish up your dissertation or any kinda classes. So that would be a challenge, just finding the time to fill out applications and write resumes and things like that. That would be the main concern, I think*. (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 67).

Thinking short term vs. long term also forces participants to consider other important people. For example, the decision to pursue a Ph.D. for participants who already had a significant other involved both parties weighing their options. This was also salient for the participants who were eager to finish their degree. When asked what people had helped support their career goals, one participant brought up their spouse. They said:

> *My wife is very supportive. I mean, we've had to kind of...I mean, going to school for so long kinda put your life on hold. We're both really eager to be finished with school, get a real job, like, settle down. And so, it's been kind of a sacrifice. But I*

> *guess she, in particular, has been very cheerful through it. So, I've been very grateful for that*. (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 121).

Thinking short term vs. long term was an integral part of participants' decisions to pursue a Ph.D., especially when factoring in financial considerations. Participants described being willing to forego an engineering salary with a bachelor's or master's degree for the future promise of a high salary with a Ph.D. For example, when asked about the factors that influenced their decision to pursue a Ph.D., one participant responded:

> *Yeah. So, job fit was probably the number one. Financial did. It definitely played in. Not necessarily...like so I guess financial, short-term and long-term. Short term in the sense that I'm going to be living as a student for four more years, so that factored in kind of on the negative side. But then also thinking about I'll graduate and get a job that's going to be, you know, it's going to pay very well. And it'll be plenty for us, you know. That definitely was a good thing as well. And I thought well that'll be nice to jump right into that. Instead of having to get in and then wait for a little while to get up to that level, you know. So, it played in*. (DS #8, Integration Phase, Research focused career [Various], Line 84).

Efficiency and Optimization

Participants expressed their desire to optimize their time while being a student. They described their degree as a long process leading to an eventual career. Part of the benefit of getting a Ph.D. was the opportunity to start at a higher salary and to bypass positions with less authority and autonomy by starting at a higher level. Participants invest the time to get a degree with the hope or belief that it will pay off in the form of financial or timesaving in a career that is more aligned with their intrinsic interests (e.g., research). When asked what value a Ph.D. gave them in terms of employment opportunities, one participant responded:

> *I think it allows you to kind of jump in towards the middle of the company hierarchy and I think that's valuable. I don't specifically want to start at like closer to the technician level and I like leading groups of people and I want to work on things that matter.* (DS #4, Entry Phase, Teaching focused career [Academia], Line 31).

Even when describing their long-term career goals and aspirations participants were concerned with efficiency in helping others such as students. For example, one participant interested in teaching focused academic careers reflected on their experience as an engineering student and how they wanted to change their teaching methods so that students did not waste their limited time. They said:

> *I mean, everyone's had the experience. You go to class, you learn the material, and you think, "Okay. That's cool." You go home and do the homework. It is nothing like the examples in class. You waste...I shouldn't say waste, but it's a waste...hours of time because there's some little thing that wasn't explained to you, or I don't know, or you just didn't get it. And so, you sit there and struggle, and struggle, and struggle to understand something to get this homework assignment completed. You don't even have a promise that you understood it. So, all that time is not necessarily...I still think it's kinda wasted a lot of time. Not all time. I think there's a value to struggle. I think you learn and remember a lot of things if you have to work for it, which is why you have to struggle a bit in life. But at the same time, a lot of that struggles wasted if you don't actually learn in the end. If you just barely get it done in time to turn it in and it was all wrong, was there any benefit to that? Not that I see. But I guess someone could argue there's benefit to that. But I don't want to discuss that right now. I just would like to dedicate time in class to letting them struggle while they have help at their hands. They're busy. I know how to be a student. Being a student sucks. It's hard. It's the best and worst time. It's the best of times, it's the worst of times being a student. It's so fun and so hard. So, I'd rather help learning occur as quickly and as*

> *efficiently as possible and reduce the amount of wasted struggle. Does that make sense?* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 76).

Participants were also concerned with saving and wasting time in their actual doctoral programs. One participant who did not have a background in engineering described how they wished they knew more about what engineering courses they could take for their program. They described how they assumed that they had to take highly specific courses within their engineering discipline instead of more applicable classes outside of their major because of their advisor's primary area of research. They said:

> *And I wish that I had known that I had a choice before starting because I took [discipline specific] courses, which are interesting. But I'm not looking for a job in, say, [discipline specific topics], even though those are the courses I've taken. I'd be much better suited, based on my research experience, for a job in, say, [similar but separate discipline], but there's a mismatch between the coursework I've taken and the research I've done. So, had I known at the beginning that I could have taken [similar but separate discipline] track, I would have done that.* (DS #5, Recent Graduate, Service focused career [Academia], Line 70).

When asked for clarification, they further described that because they did not take engineering courses as an undergraduate, they had to spend most of their doctoral coursework playing "catch-up" on courses they already had scientific background in such as statics, dynamics, and fluid mechanics. The participant wished their doctoral courses were optimized in a way that benefited their prospective career. Similarly, when asked this same question, another participant also wished to save time in their program by having a better alignment of previous work and skills to what they were currently doing. They said:

> *What I wish I knew? I mean, with my work being highly involved in, like, numerical modeling, I wish I had a better background in it. My master's work was nothing even similar to this, so. But my master's was just trying to get my foot in the door for, like, research and finding out whether or not I like research or not. I wish I had known, like, or I wish I had been doing similar work to this in my master's, so I would have been a little bit more up to speed and prepared, because I've noticed that learning new skillsets and reading new literature takes a bunch of time, and that's the one thing that I always find myself having to like catch up on. So, I guess that's what I wish I knew more of going into it.* (DS #6, Integration Phase, Research focused career [Government], Line 59).

4.1.3.3 Time Adaptive Tactics (TATs)

Both subjective and objective experiences of time were an unavoidable reality for the participants. Objective deadlines and time spent negotiating their various professional roles (e.g., doctoral student, research assistant) and personal roles (e.g., spouse, parent) are built systematically into day-to-day life. However, participants are clearly considering and are affected by conceptualizations of their future careers before and during their doctoral student experience. Considering the short term vs. long-term benefits of any experience (e.g., professional development, dissertation research) and allocating time based upon that analysis is something participants decided for themselves. However, a focus strictly on objective (present) time or subjective (future) time at the expense of the other can be potentially detrimental. Participant interviews in their entirety reflected aspects of experiencing, describing, and reacting to time not just objectively or subjectively, but in relation to other actors such as employers, their families, and their departments. The way these participants navigated these different socially constructed timeframes was through Time Adaptive Tactics (TATs). TATs consider how individuals interact with the world and create a shared experience of time. Because timeline considerations such as those associated with degree requirements, timing of funding, job applications, and a student's graduation are all constructed by different actors within a larger system, TATs allows individuals to navigate multiple interpretations of time in a way that is beneficial to all parties.

A full range of tactics were coded during the first cycle coding of thematic analysis (i.e., dramaturgical coding), which are associated with other themes (e.g., Engineering Doctoral Identity) or perceptions of time (i.e., Objective and Subjective time). For example, the tactic of survival was mostly associated with Objective Time, pursuing a Ph.D. to qualify for desired employment is associated with Subjective Time, and navigating departmental culture was associated with Engineering Doctoral Identity. TATs emerged as a separate Time category because aspects of both Objective and Subjective time were incorporated and integrated within these tactics. These tactics were: (a) flexibility, (b) networking, and (c) using career resources. These three TATs were the most frequently coded tactics (45, 41, and 39 codes respectively) for the nine doctoral participants. The average frequency of coded TATs by career function is provided in Table 4-7. While these TATs were important across all participants, some participants mentioned them with greater frequency, which can be observed in Figure 4-7. Higher frequencies are indicated by the size and color of the square, where large red squares indicate high frequencies. For example, DS#3 mentioned the Using Career Resources more frequently compared to all other participants as observed by the largest square in Figure 4-7.

Table 4-7. Average frequency of time adaptive tactic codes by career function.

Time Adaptive Tactic	Total codes	Average codes per participant by Career Function		
		Research	Teaching	Other
Flexibility	45	5	5	5
Using Career Resources	41	5	3	7
Networking	39	2	5	8

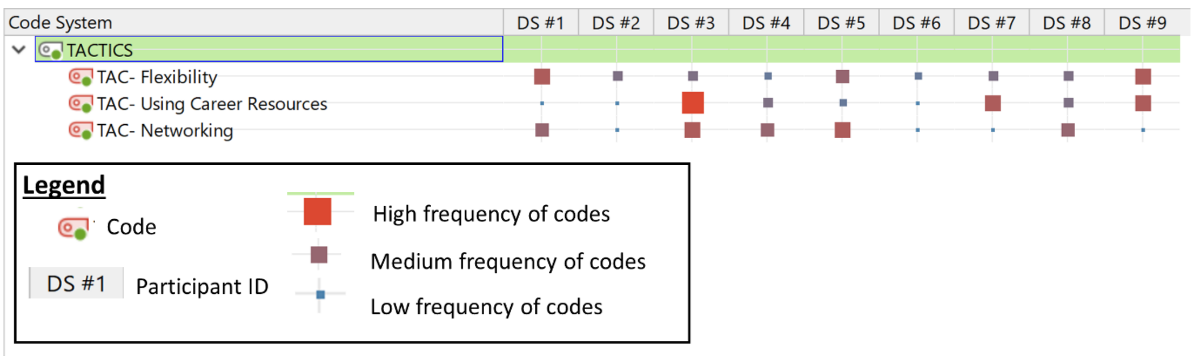


Figure 4-7. Screenshot of MAXQDA 2018's code matrix browser (VERBI Software, 2017) of Time Adaptive Tactic coding frequency by participant.

Flexibility

Flexibility was the most frequent tactic coded for the nine participants in this study. Flexibility involves being open to different types of careers or employment opportunities that do not meet an individual's ideal career or life. This can include taking temporary positions or looking at unexpected careers (e.g., CIA). This also includes alternative pathways to a career objective, making incremental progress towards that objective, making compromises, reframing negative aspects into positives, and taking opportunities as they come, even if they are not ideal. Participants showed flexibility in their decision to pursue a doctoral degree, the types of careers they would consider and what compromises they would be willing to make in their first postdoctoral career. Several of the participants had never intended to pursue a Ph.D. but were convinced by faculty or others to pursue it. For example, one participant took an opportunity they never initially considered. They stated:

> *I originally had not planned to do a Ph.D. Going through my undergrad, I decided that I would try graduate school. And I did my undergrad and my master's work also at Utah State, so I've done it all here at Utah State. And I started working with [my research advisor]. I took a class from him my senior year for my undergrad. And I decided I was gonna do graduate school, then he asked me if I wanted to do research for my master's. So, I was planning on just doing coursework, and I really enjoyed doing the research. I liked it a lot, and that was one of the main reasons why I decided to stick with Ph.D. was because I enjoyed the research. I really enjoy it. I enjoy classes and coursework as well, but the research, it's definitely for me. And so that was the main reason I chose to do a Ph.D.* (DS #9, Integration Phase, Research focused career [Academia and Industry], Lines 37-38).

Another participant was also influenced by their research advisor to pursue a Ph.D. and they reconsidered their career path. They said:

> *This is not something that I thought of when I was a kid. You know, I didn't want a Ph.D. in engineering. It just sort of happened. And I'd say that the real reason that it did happen was because my advisor gave me confidence it's something that I could do, and it's something that she encouraged me to do. So, with that little push, I took on a Ph.D. position, not necessarily knowing what it entailed in full, but it turned out to be a great experience*. (DS #5, Recent Graduate, Service focused career [Academia], Line 45).

Another participant recounted that before they decided to pursue a doctoral degree, they initially only wanted a master's degree. They said:

> *So, when I came into school, I knew I wanted to work with aircraft. And I wanted to come up with new aircraft designs and concepts. And I originally thought, okay, I could do that with a master's degree. I was always planning on doing a master's degree, but I was going to do a coursework master's. And so, I went through my bachelor's degree and got in the concurrent master's degree program and started to do a plan C or coursework masters.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 63).

When this participant was approached by their future research advisor to help with research as an undergraduate during their last semester of undergraduate study, they agreed to work a few hours a week without being paid. They enjoyed the work so much that they continued working with the professor until it morphed into a paid research position as they worked on their master's degree. By being open and flexible by accepting an unpaid research opportunity, the participant discovered an interest in research which opened up potential career paths they had never considered before. The participant continued to say:

> *And I still thought that I was just going to get a master's degree and leave. But about halfway through my master's degree, I realized in looking at jobs and looking for the types of jobs that I wanted, that almost all the jobs either required a Ph.D. or a Ph.D. was preferred. And so, I thought, "Well, this might be something I want to do." So, I thought about it a lot and I talked to my wife about it and we talked a lot. And, we decided that it felt right. And so, we decided to do the Ph.D*. (DS #7, Integration Phase, Research focused career [Academia and Government], Line 66).

The participants showed flexibility in the types of jobs they would consider and apply to. While participants had a clear preference for career function (i.e., research, teaching, service, engineering), they were open to considering multiple types of careers with an exception of two participants (i.e., DS #2, DS #6). DS#2 pursued a Ph.D. to be qualified for tenure track positions in academia, and DS#6 wanted to work in a research lab and was wary of academia from what they observed so far as a student. Some participants' flexibility on considering future careers arose out of a fear of academia being competitive. For example, when asked what types of careers they were considering one participant responded:

> *It depends how I'm feeling. So, I would look at academia jobs recently over the last probably six months or so. I have this fear that there will be no jobs in academia when I graduate, and I know that is not super practical. STEM is growing and universities are opening and they're considering more professors of practice lately. And so, like, I probably shouldn't be that worried about it, but I worry, and I know there are only so many faculty positions that open every year. And I don't know. I guess I'm a little nervous that I won't be picked, I guess. I also look at industry jobs. And like recently, I've been looking at jobs with Space Dynamics Lab. I have a couple of friends who work there and they're expanding a lot in Albuquerque right now over the next five years as they've built some new buildings down there. So, I've been looking at like living in Albuquerque and kind of just wherever my mood takes me is where I look for jobs. It's not very structured.* (DS #4, Entry Phase, Teaching focused career [Academia], Lines 65 and 66).

Many participants idea of their future career evolved over time, where they initially considered industry jobs typical of engineering fields but exposure to research opened up different possibilities. One participant was so open to the idea of different careers that they said they had to stop looking at job boards because they could not figure out what they wanted to do. When asked about their long-term career goals they replied:

> *So, I mean, though, this is kind of funny, ending up in a kind of a funny time in my career life, kind of having an identity crisis right now. […] So, I went to a STEM career fair recently, just for fun to explore, more of look for companies as opposed to look for jobs because with were two years left, I'm looking for the types of companies that have jobs I like as opposed to specific jobs. Because all the jobs they have now will be filled by the time I graduated. So, I mean that's worthless. But going and talking to different companies about job fields that they have and the type of work they do has been really valuable. So, but anyway, so there I talked to Northrop Grumman and they ended up inviting me back for an interview for an internship next summer. And so, I interviewed there. I ended up also just for fun talking to the FBI that was there and seeing what life was like there as a special agent or an analyst, things like that. And so anyways, it's been kind of interesting because I've kind of...I played a lot of the what if game with the FBI. Like, you know, like, what if I would wanna take all everything I've learned but do it as more of, like, an analyst or, like, in the fields type application as opposed to the more rigorous engineering application*. (DS #8, Integration Phase, Research focused career [Various], Line 75).

They began to realize that what they really enjoyed doing was conceptualization of aircraft design and writing analysis tools or simulators, and that they realized they could apply this to other careers such as the FBI, Formula One racing, or even starting their own company. Another undecided participant who had a part-time industry job throughout their doctoral program considered academic research and teaching positions, academic administrative positions related to research, and tailoring current industry positions to better suit the skills they developed. For example, when asked what types of careers they were considering, within their detailed response they included:

> *I'll just say getting into things and some of these are with organizations that I know these types of roles exist in and some of these are like business ideas I've*

> *had where I wanna start a company to do this. But I've thought about trying to have a position where I'm helping new hires on board better to help companies better identify where they should be investing their training dollars, how to align their organizational goals for development in the directions they wanna move with a lot of their other HR stuff like how they treat their employees and what sort of training opportunities they offer […]* (DS #3, Recent Graduate, Engineering focused career [Various], Line 56).

Throughout their interview, they also brought up strategies on how they might enact their ideas or create a position that incorporated all of their skills and job fit characteristics. While this is one of many ideas they had, they concluded their thoughts by articulating their current tactic, "I have way too many ideas and I need to pick a couple and focus on them and by default, I'm just gonna stick with my current job and keep doing what I'm doing." (DS #3, Recent Graduate, Engineering focused career [Various], Line 64).

Another notable way participants were flexible was through their considerations of less ideal jobs for their first job after receiving their degree. For example, one participant interested in teaching functions in academia was willing to consider postdoctoral research positions if they helped them become a more attractive candidate for employment. This flexibility even extended to other job fit characteristics like work-life balance and location. They stated:

> *If there were no jobs available that totally aligned with what I was interested in, then obviously I would have to take something that didn't. And then otherwise, it would probably come down to things like location and work-life balance. So, if I had a job opportunity in a location that I absolutely didn't wanna go, but it aligned with what I wanted to do versus in a location that I totally wanna go and it doesn't fully align, I think I would consider the one that doesn't fully align just because in the long run, I think that's gonna affect work-life balance opportunities*

> *outside of my career way more than the one over here.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 114).

Another participant who listed location as one of their most important job fit characteristics (Table 4-2) when reflecting on what compromises they would make in getting their first postdoctoral job stated:

> *I think it would probably come down to like the quality of the work and, like, how well I saw myself doing that work, and being able to progress my career by working for this entity. And I would probably forego any sort of, like, location constraints, or at least try to reconsider them. But, I mean, luckily a lot of places working in the Colorado River Basin, like I am, I think it will set me up. I mean, I'm hoping that sets me up to put me in places within still the Colorado River Basin and anywhere in that region is likely acceptable for me. So, it would just have to come down to how valuable the work or how good of an experience I could get out of that job.* (DS #6, Integration Phase, Research focused career [Government], Line 102).

All participants were willing to make some compromises for their first job after attaining a Ph.D. as long as they could envision this as a stepping-stone to a more desirable career or if the long-term benefits (e.g., skill development) outweighed the short-term costs. This was true even for academic-career seeking participants who were primarily interested in teaching. They mentioned they would accept a postdoctoral research position to increase their number of publications, but only because it was inherently temporary and it would help them achieve a more desirable position. Ultimately, flexibility required an understanding of the present situation (i.e., objective time) balanced with looking towards the future (i.e., subjective time).

Networking

Networking was the third most frequently coded tactic. Networking is utilizing and leveraging an individual's current network of professionals (e.g., major professor, departmental faculty, alumni) to attain a future career or temporary position. This includes using academics, professionals, and student and professional organizations. Networking can be done formally (e.g., conferences) or informally (e.g., advisor contacts one of their peers). Networking inherently involves a relational component where connections built during the participant's doctoral program may eventually yield future career benefits. Networking involves expanding and utilizing a participant's social capital (Bourdieu, 1986), which for these participants primarily involved their research advisor/major professor. All potential 'characters' were coded during dramaturgical coding as a part of developing narrative. This also served a dual purpose to reveal what people were most important in considerations of their current role as a doctoral student and in how they intended to pursue their future careers. A visual frequency of character doctoral student participants mentioned is provided in Figure 4-8. Participants mentioned their faculty advisor (i.e., major professor or research advisor) most frequently followed by their significant other, and other faculty. When checking the relationships between the character codes and the tactic of networking, the strongest co-occurrence was found with faculty advisor followed by department and faculty, and peers or colleagues.

Figure 4-8. Screenshot of MAXQDA 2018's code matrix browser (VERBI Software, 2017) of character coding frequency by participant.

Research advisors served an important role in providing letters of recommendations, scholarship recommendations, alerting participants of job opportunities, and offering career advice. One participant, because they were seeking academic careers, stated that they trusted their advisor to have a better idea on how to get academic positions because they were part of a faculty hiring committee. For example, when asked about sources of career support, the participant responded:

> *So, I mean, my advisor has been incredible. He's always looking for opportunities for me to work on projects that would be useful to me or help writing papers, or finding jobs, or if I have questions, we've spent a lot of time. When I have questions or ideas or thoughts, he's been an excellent source of support for me. The others in my department are helpful as well. When I have questions, I can go to them. I mean, they're all on my committee. There's only four of them, so four professors. I mean, we have adjunct lecturers as well, but four assistant associates or full-time professors. So anyway, they are very useful and helpful. They have granted me the opportunity to teach this semester, which I mentioned, which is extremely supportive and helpful. And they've also helped me by writing letters of recommendation for scholarships and jobs as I needed them. So, they're very helpful.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 125).

Participants also used the tactic of networking by utilizing professional societies and going to conferences. These professional societies could be student organizations run on campus and/or groups that held annual conferences that participants attended. For example, one participant used their professional society's job board. They stated, "Occasionally I guess I would look at like ASEE. American Society for Engineering Education has job boards, but those aren't totally comprehensive. So, I don't look at that a lot, but basically online." (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 118). Another participant remarked on how they used a professional society when looking for advice on careers. They stated:

> *I also go to professional societies like Geologic Society of America, they offer a decent number of student resources. And like at their annual meeting, they have student mentoring sessions and, like, something as simple as resume reviews, and revamping, and stuff like that, which I'm sure it's something that I could also do here. I haven't looked for it. [...] I just know that that service is available through these professional organizations. And so, I know to look for them there. I have not looked for them [at my university] even though, thinking about it now, they probably exist.* (DS #5, Recent Graduate, Service focused career [Academia], Lines 140-144).

Participants knew about multiple professional societies that offered career resources. One participant brought up their involvement with a student section of Society of Women Engineers (SWE), which put on a professional networking event called Evening with Industry and also their involvement with a Women in Physics group on campus. Another participant was highly specific about what type of career resources they would utilize from different professional societies. They said:

> *If I'm looking for training or seminars, I'll look to professional organizations. I mean, I'm doing a lot of research with concrete, prestressed concrete. So like PCI, PCA, Portland Cement Association. PCI is Precast Concrete Institute. American Society of Civil Engineers, ASCE, has a lot of good things. When it comes to teaching resources. I'll read a lot of papers from ASEE, right? American Society for Engineering Education or whatever it stands for*. (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 119)

Using Career Resources

Using career resources means that a participant utilized any on campus or off campus resources (e.g., trainings, seminars, websites, advice, people) that directly or indirectly contribute to skill development, searching for, or attaining employment. This also includes seeking out contextually specific career resources (i.e., resources for STEM doctoral students). For participants, using career resources involved coordinating timelines between multiple groups in an attempt to attain a future career. Participants had to evaluate the utility of each resource they were aware of and whether it was worth their scarce and limited time. If they perceived that the future career benefits outweighed the present cost, they pursued this resource. However, if they perceived the objective time cost was greater than the subjective future benefit, they would not utilize that career resource. Less time and people intensive resources like internet resources which they could access on their own time (e.g., job boards) were a safe time bet for participants while attending trainings and seminars for graduate students (e.g., Graduate Training Series) presented more of a potential time cost. Participants perceived the least return on time investment to be with Career Services because they believed they did not have the experience to provide information specific enough to engineering doctoral students. These participants were looking for highly specific and uniquely tailored career advice and resources that they perceived only certain individuals or groups would be able to provide. One participant illustrates this point when reflecting on if Career Services had the ability to help with finding academic careers. They said:

I don't know. Probably, but I don't know. I have never really looked at it. Just because I have always had that impression oh, it's if you're going in industry and you're getting a bachelor's degree, and even at that level it seemed like a lot of their job opportunities were for everyone, in every field and every degree program. And so, if you're looking for something very specific, and even in an engineering industry, it was not always career services was not always the easiest route to find that. But again, I can't say that I totally looked down that path just because there were other resources just online that I would always go to. (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 140)

4.2 Discourse Analysis

The engineering doctoral participants provided the majority of the data for this dissertation. However, as part of the methodology to analyze these responses within their current context, university staff that offer career services or have professional responsibilities towards graduate students were contacted by email to participate within the study. After expressing varying levels of interest, university staff from Career Services, the School of Graduate Studies, College of Engineering, and Library staff were approached for informal and formal interviews. In order to reduce the risk of broken confidentiality, staff were allowed the option not to be recorded. Only one staff participant consented to be audio-recorded while the rest engaged in informal conversations about their respective offices or job functions. Of particular interest to this study were Career Services (CS) and the School of Graduate Studies (SGS) who did not formally participate but provided career resources, guidance, and information about the Graduate Training Series (GrTS) which was frequently mentioned by the doctoral students within this study.

All doctoral student participants were asked how the university helped with their professional development and were prompted to comment on Career Services (CS). After these interviews were completed, staff participants were informally interviewed using the preliminary analysis of doctoral student perceptions. Staff data collection revealed there is a discourse in how doctoral students and university staff perceive career resources on campus. Doctoral students did not see much utility in accessing CS as a doctoral student despite their high praise for CS resources which some utilized as undergraduates. In contrast, CS staff asserted that they could help graduate students including engineering doctoral students and that they had been successful in doing so. Further analysis revealed that resources that were more contextual (e.g., more specific to engineering doctoral students) were placed in higher regard by those students. Another factor that influenced doctoral student perception of resources was the relative proximity of resources to the students in location and time. Resources brought into proximity of engineering doctoral students are those that offer different ways to access these resources in location and time. For example, offering both broadcast and recordings of a professional development seminar would be increasing the proximity of that resource. Proximity was also governed by physical proximity (e.g., faculty inviting university staff into classrooms or seminars). When insiders such as faculty bring a resource directly to engineering doctoral students, this conveys acceptance and high value of that resource.

4.2.1 Doctoral Perception of Career Resources at USU

Participants placed high value on advice, guidance, or resources that came from ‘insiders’ (e.g., research advisor, committee, faculty). Throughout their interviews, participants were asked four questions specific to career resources to determine what career resources they were aware of specifically on campus. Doctoral student participant reported sources of career advice and support are summarized Table 4-8. Doctoral student participants were more likely to utilize and value ‘insiders’ (i.e., primary research advisor, other faculty) for career advice and support over sources of support such as Career Services. The School of Graduate Studies (SGS) emerged as an important source of support for participants. This support was primarily in the form of the Graduate Training Series (GrTS), a grant writing workshop, and fellowship specific support. The participants also brought up their respective professional societies (e.g., Society of Women Engineers, American Society of Civil Engineering.) as an importance source of career support. The participants utilized professional societies through being involved in student sections at USU, attending conferences, and searching job boards on their websites. Career Services was mostly brought up as being useful during participants’ undergraduate experience, but rarely utilized as a doctoral student.

Table 4-8. Sources of career advice or support for doctoral student participants.

Source of Career Advice or Support	**Classification**	**Participants who have used this support as a graduate student**
Primary research advisor	Insider	9 out of 9
Faculty	Insider	7 out of 9
School of Graduate Studies	Insider/Outsider	6 out of 9
Peers (fellow graduate students)	Insider	4 out of 9
Professional Societies	Insider/Outsider	4 out of 9
Career Services	Outsider	2 out of 9

One resource that emerged from participants' interview were the use of library resources. When asked about professional development activities on campus, a participant stated:

> *I am very appreciative for what [a staff member] and the library offered. I never really talked to her one-on-one other one, except when she came and spoke at our department seminars and stuff like that. And that was good information to have, but just how easy they make it for grad students to get stuff off a billion, awesome. So cool. So that was a great resource. Not in like a mentoring role, but as far as resources go, that was really nice. It has been nice.* (DS #3, Recent Graduate, Engineering focused career [Various], Line 135).

This prompted inclusion of library staff into the pool of staff participants. The, participants did not mention the use of Graduate Programming Coordinators (GPCs) as a resource. This resource may warrant additional exploration on their role in providing professional guidance to graduate students.

4.2.1.1 Awareness of Career Options vs. Exposure to Career Options

Dramaturgical coding of conflicts revealed that the second most frequently mentioned conflict after short term vs. long term was awareness of career options vs. exposure to career options. Some participants reflected that they did not know much about what it meant to have a Ph.D. or what type of careers were available to Ph.D. recipients upon entering their programs. While participants gained some exposure throughout their programs, some felt this exposure came too late to actively shape the professional development opportunities they pursued. For example, when asked what they wished they knew about their program before deciding to enroll, one candidate responded:

> *I wish I would have had a little better introduction to the options with Ph.D. So, for example, we kinda talked about academia and industry. I wish I would have understood better. I feel like I understand that just from my correspondence with people in both academia and industry. But for example, I wasn't set on going into academia from the get-go of my Ph.D., like I kinda decided that quarter to halfway through. For sure I knew when I started that it was a possibility, but I was still thinking I would get a Ph.D. and then go into industry. And I wish that I had just known what options I would have because I was always kind of uncertain about it. Really, I was just pursuing it off of faith. I felt like this is what I was supposed to do, so I just did it. But for example, if I had known the career prep things that I wanted for my CV, I didn't even know the CV was when I started my Ph.D. Right? Everything was a resume. If I had had some career preparation at the beginning of my Ph.D. that would have been useful, then I probably would have pursued certain things like maybe other activities. If I had seen a CV to start with and seen, oh, so publications, everyone talks about publications, but that's only part of your CV. I would have probably been more involved in other organizations, maybe pursued more volunteer work. I would have pushed harder from the beginning to get publications out because I didn't realize how long it takes to publish*. (DS #1, Candidacy Phase, Teaching focused career [Academia], Lines 58-59).

When asked what the university could do to further support their career development needs, one participant stated:

> *I think I'd like someone in Career Services who's specifically for grad students. One of the biggest reasons I haven't gone is because they all focus so much on undergrads which is practical, like that's most of the university and I think it's a big goal of lots of the students here is to get a job. But I'd like someone who can walk through the differences of moving onto a Ph.D. or moving to industry or like going into academia, going into a postdoc, moving into a new startup. And I think a lot of students find that useful. It'd be hard I'm sure for them to find someone for that because they probably don't have funding to do it for each college or it would probably be a one-size-fits-all sort of model. But even then, I think it would be more valuable than grad students visiting with like the undergrad career advisors.* (DS #4, Entry Phase, Teaching focused career [Academia], Line 143).

This participant would have liked someone at the university who was aware of all types of postdoctoral careers whose specific function was to advise students on them. Some participants reflected that they did not know what they wanted to do until after exposure to doctoral programs. For example, one participant brought up potential career paths they were considering before their doctoral program which were appealing but not ideal because of the routine involved. They continued:

> *I didn't know what it was that was missing until I started a doctoral program. When I then had experience working with researchers and those who were developing techniques, pushing the boundaries, sometimes failing, but having the latitude to try and to pull in, you know, concepts from medicine or other disciplines to try to solve problems in a new way. And I didn't realize that that's what I was missing until I kinda saw it in practice.* (DS #5, Recent Graduate, Service focused career [Academia], Line 61).

When participants were given opportunities to learn about other types of careers, they found them valuable. For example, one participant reflected on an opportunity they had to learn about the career path of university administration and how that opened their eyes as to how they got into those positions. This type of opportunity was only available under special circumstances (e.g., fellowship), but provided a rare insight that many students do not have. The participant said:

> *And then like I said, the ones with the fellowship that people would get up and just talk about how their career developed over time and, you know, how, you know, I got to hear [the university president] speak once or twice, you know, about how, you know, she wasn't focused early on, on being an administrator. And none of them are initially, they're all focused on their research or their students. [The university president] was focused on the research, most of the others were all focused on students. And just hearing how they, you know, and I think it's just insightful to see, especially with this university president and how they see things tie in together, I think that's useful information to have. You know, and it is encouraging to me that, you know, they all had a passion for their students or their research and not for being in administration. At least that's what they say. And a lot of them, as they describe how their careers progressed, that's what it sounds like.* (DS #3, Recent graduate, Engineering focused career [Various], Line 134).

4.2.1.2 Utility of Career Services for Engineering Doctoral Students

The participants had often-contradictory views on Career Services. On one hand, many of the participants utilized Career Services as undergraduate students and found them helpful and effective. When asked about career resources they utilized on campus, one participant stated:

> *In my undergrad when I was preparing for internships and things like that, I used some of the career resources for, like, resume workshops and things like that. But it's been a while since I've used those. You know, I went to those, got tips on my*

> *resume, and then I've just been iterating on that type of resume since. So as of late, I haven't used any necessarily on-campus resource. Well, I did go to the grant writing workshop, so, I guess, if that's considered a career resource, I did use that and that was very valuable. I thought, you know, that was really good. I mean, I went to the STEM fair, so that's an obvious career resource that I use. I guess I forgot. Also, you know, I went to, like, some info sessions and things like that for companies that have come, like, ANSYS and Northrop Grumman, and I went to both of their info sessions when they came here and talked about their companies and what they've done. So, I've used resources like that. I guess it has become very valuable to...Anytime that I can have a face-to-face conversation with a company, it gives insight into things that you can't find on their website, I guess, a little bit of a peek into their culture and things like that*. (DS #8, Integration Phase, Research focused career [Various], Line 113).

Another participant reflected on how they utilized Career Services as an undergraduate and master's student by stating:

> *They went through my resume with me, they talked to me about interviewing. They were just good sounding boards for stuff. We put together the fall career fair, very receptive and very nice to work with. And so, as a master's student, they weren't very big as a Ph.D. student since I'm employed.* (DS #3, Recent Graduate, Engineering focused career [Various], Line 129).

However, when participants were asked to clarify if they had used Career Services as a doctoral student they had not. One participant brought up several Career Services sponsored events they had attended such as career fairs and networking events. When asked if this was during their undergraduate education, they replied, "Yeah, yeah, my senior year, I did that. But since I've been a graduate student, mostly my career, if I have a question or want advice on career, I usually go to my professor and talk to other students." (DS #7, Integration Phase, Research focused career [Academia and Government], Line 170). Another participant when asked about on-campus professional development events spoke highly of the GrTS seminar, but when considering Career Services, they stated, "…but I haven't really done that while a graduate student." (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 110). A participant who did not attend USU during their undergrad was unaware of what the university offered. When asked about how the university could further support their career needs, they stated:

> *So, I just am not aware of where to go or even what to look for. I mean, I know there's Career Services. I've always been under the impression that that's not for Ph.D. students, it's more for bachelor students, people who are trying to get a job outside in industry. But maybe that's not the right...it's just a misconception but yeah, it's just awareness, which I'll take the blame. I'm not...I haven't been that interested in seeking out what the university has just because there are other resources online that are available.* (DS #2, Candidacy Phase, Teaching focused career [Academia], Line 138).

Another participant earlier in their program stated that they had not participated in any professional development activities on campus. When asked if they had seen any that had interested them, they responded:

> *Not really. I mean, I've probably seen some, but I've... Maybe I have seen some and I've just like ignored most of those emails, like any sort of... I guess there's always the emails that are for, like, you can sit down in the engineering building was some career professionals and I just, they say, "Oh come and there's free pizza." And I just ignore those emails. But I mostly think those are geared towards undergrads too. So, yeah.* (DS #6, Integration Phase, Research focused career [Government], Lines 132).

Career Services still held value for one participant. While this participant primarily brought up faculty and family as current sources of career support, they still acknowledged the influence Career Services' had in giving them valuable tools during their undergraduate experience. They stated:

> *I think [Career Services] has helped me the most, like in actually not so much shaping what I want to do, but in allowing, like giving me tools to be able to get the types of jobs I want. So, like internships comes to mind, during my undergraduate I tried to get some internships. And I went to Career Services a lot to help write a good resume and a good cover letter. And so, Career Services has really helped to, I guess, give me tools that I need to get the job that I want. But not so much shaped my job search journey or anything like that.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 181).

4.2.1.3 GrTS and Other Graduate Student Specific Resources

The majority of doctoral student participants considered the School of Graduate Studies a source of career advice or support. The resources most frequently mentioned was their Graduate Training Series (GrTS) and a grant writing workshop that a few had attended or heard of. GrTS is a monthly series of seminars and/or workshops that are structured around graduate student needs at the study site of this dissertation. GrTS topics are selected through student surveys and focus groups. GrTS also elicits student feedback on the best time to offer seminars and also includes video recording and resources of previous sessions. The most mentioned session among the participants was a session on teaching undergraduate courses. This is a session that has been offered several years but most recently September 2018 where both graduate students and faculty were part of a panel on tips for teaching and mentoring undergraduate students(School of Graduate Studies [SGS], 2018). For context, this seminar was the most recent GrTS session before the doctoral student interviews were conducted. When asked what they got out of this seminar, one participant replied:

> *I feel like I have a better understanding now of what would be expected of me as the new undergrad teacher and a better appreciation for how hard it is. I guess I assumed that teachers, like before I started in [my program], that teachers just go in and talk about what they know, and they cover chapter 3 of the book on the 3rd day and like follow it super closely but it's not always the case. [...] And it was cool to think of some ways that teachers on campus have taught and ways I could hopefully implement someday.* (DS #4, Entry Phase, Teaching focused career [Academia], Line 112).

Another participant talked about how they attended a few GrTS sessions, but they are now more selective about which ones they attend. When asked about graduate student specific professional development and the GrTS sessions, they said:

> *Yeah. I've been to like three of those, I think. And those are good. I like those. But I kind of like pick and choose on those ones because some of them don't interest me as much but some do. And so, yeah, I have gone to those. And those are helpful. Those are good. I went to the...they had a grant writing one recently. That was really good.* (DS #7, Integration Phase, Research focused career [Academia and Government], Line 192).

When asked to elaborate about their experience in the grant writing workshop, they replied:

> *It was good. Yeah. I think it was a lot to kind of pack into a day. And I know why they do it that way. So, it's just kind of a lot of information. But the presenter gave us like a workbook and like a big reference manual. So, like all the stuff that we learned is in there. So, it was a good reference. Yeah, it was good though. I enjoyed it*. (DS #7, Integration Phase, Research focused career [Academia and Government], Line 198).

Another participant mentioned that they presented at an Ignite event that takes place during Research Week. They recounted how the uploaded video of their presentation had helped give them name recognition with future employers when they search the internet for their name. They concluded their thoughts on Ignite and graduate student specific resources by saying, “So I said the graduate school would be the other folks at the university who have helped me develop the skills that I'm seeking for to obtain my career goals.” (DS #5, Recent Graduate, Service focused career [Academia], Line 154).

Graduate student specific resources such as GrTS and other workshops were perceived as most useful to them although they acknowledged their limits. For example, GrTS was communicated as needing to appeal to all graduate students of varying backgrounds, disciplines, and contexts. One participant who found the Teaching strategies in the GrTS seminar were valuable caveated their statement by saying:

> *Not all of it applies too much towards engineering, I don't think, because there's a wide variety of majors and just topics. The way to go about teaching English is very different than the way to go about teaching engineering or math, for example.* (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 108).

This participant reiterated their need for more contextually-specific resources for doctoral students and for *engineering* doctoral students. When asked what the university could do to further support their career development needs. They responded:

> *If they could include a seminar or, I guess, the research of graduate studies could put on a monthly thing that kinda went into the different fields that are out for a doctoral student, like just talking about academia versus industry, what's out there would be nice, just so you could kinda see what options are available. And*

> *then a couple tips or recommendations of what you could do to try to get your foot in the door in either academia or industry*. (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 114).

The participant clarified that the doctoral student context was important by saying:

> *So, you could say if you're a doctoral student, academia is a big option. So, describing the pros and cons of going into academia, what you should focus on if you do that, what you should expect as you start to work there or as you get into work, what you should strive for. And then also on the other side, if you wanna go into industry, what you should expect industry to expect from you having a Ph.D., what kinda positions companies are hiring for, requiring a Ph.D. and maybe what's out there, I guess.* (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 118).

They acknowledged that hearing from non-engineering fields was slightly valuable but then said:

> *It would be most valuable from engineering, from your same field in engineering even. But I think it would have some value even if you're for mathematicians or for other majors. I think it would be most useful if it stayed within the STEM, the science, technology, engineering, mathematics kinda fields, so it was kinda more related to what engineers are working on. But I do think it would be beneficial.* (DS #9, Integration Phase, Research focused career [Academia and Industry], Line 120).

4.2.1.4 Preference of Career Support from Insiders

Through their responses and emphasis, it was clear that participants clearly preferred to receive career advice from 'insiders' in their discipline (e.g., faculty). This was also evident in the frequency in which participants brought up insiders when considering their current context and intended career paths. As part of dramaturgical coding, characters (i.e., other people within doctoral student narratives) were coded throughout the entirety of participant interviews. Faculty research advisors were the most frequently mentioned character (51 codes) followed by the participant’s significant other (28 codes), faculty (27 codes), and student peers (22 codes). Participants’ significant other did not provide career advice or resources, but instead offered support (e.g., emotional, financial) and were an important consideration in deciding to pursue a Ph.D. and in their future careers. For career advice and resources, participants felt that insiders such as their research advisor and faculty were the most useful. Participants cited various reasons, but the most salient was that individuals who had a Ph.D. were better able to provide specific and specialized career advice to doctoral students. For example, when asked if they had ever used university services such as Career Services, one participant stated:

> *With a doctorate, the kind of job search for academia is much different than it is for industry. And so, my impression of Career Services is they are good at helping you get a job in industry. […] I just kind of assume that the people that know how to get a professor job best are professors and I'm surrounded by them. So, I don't know if that's just prideful on my part, but I feel like Career Services, I assume they...maybe they...I'm sure they have some kind of training on that, but I bet they don't get many people in there, enough that they're familiar with it. They might have been trained when they started their job on how to help academics try to find jobs, but I am assuming they don't use that and for that much, they're probably rusty on it or they don't know. They are willing to help with my resume, but I never see them say, "Bring your CV and we'll take a look at it.”* (DS #1, Candidacy Phase, Teaching focused career [Academia], 127-129).

It is important to note how the participant also brings up that insiders surround them. These insiders are, in a way, closer not only to the participants’ identities but also in location.

Participants not only described how only insiders such as faculty were capable of helping them find academic careers, but also that academia had specific recruitment materials such as the curriculum vitae (CV), research statement, and teaching statement that requires a contextual insight and knowledge that only insiders have. One participant specifically mentioned the CV and how they were unsure if Career Services knew contextual and strategic inside information on how to help them get hired in academia. They said:

> *I don't know that they don't know how [to build a CV], but I don't know if they are very familiar with the logistics of what you need, how to actually get a job in academia. Because they don't...well, they never got a job in academia. But their job is a sort of industry job—not that its industry, they work for the university. But getting a job as a secretary or an adviser or a counselor, I think is different than getting a job as a professor. Getting a job as an engineer, use the same skills to get jobs like those. But I don't know what other positions use a CV. I think medical field uses CV; I believe. That's it. Like, and the CV for medical field, I mean, I'm assuming doesn't have a lot of publications on them. It's going to include more for medical experience, but I don't know.* (DS #1, Candidacy Phase, Teaching focused career [Academia], Line 133).

4.2.2 Staff Perceptions of Offering Career Resources

Staff from Career Services, the School of Graduate Studies, the Library, and other engineering departmental staff were formally or informally interviewed and asked to identify career resources. Unlike doctoral student participants, they did not articulate the importance of having an insider perspective; instead, they elaborated on the value and utility of the resources they had available. While staff participants, in general, believed they offered valuable resources that all types of students could benefit from (i.e., undergraduate and graduate students), some participants articulated the importance of offering resources in a more time adaptive way rather than an objective framing of time.

4.2.2.1 Campus Resources

The doctoral student participant interviews revealed they did not perceive campus resources like Career Services to be useful to them at their stage of education. Career Services, on the other hand, expressed confidence that they could help all types of students through their variety of resources and one-on-one career counseling. The participant drew attention to their website and the multiple and organized career resources on it.

Career Services offers an interactive website that has many resources ranging from resume help to a job board specifically for alumni and current students. They host several career fairs throughout the year including STEM specific career fairs. They offer a Canvas course that has all of these resources with videos that explain how to use the resources. Career Services also offers the opportunity to meet with a career coach specific to engineering and a convenient way to request a custom-tailored presentation to classrooms, clubs, or other campus venues. Career Services has specifically been brought to graduate students through GrTS with seminars such as Preparing for a Career Outside of Academia, Prepare for Your Career in Academia, and Tips for Interviewing for a Job. In contrast to what a doctoral participant stated, Career Services offers Curriculum Vitae (CV) help and even resources on converting a CV into a resume.

Career Services agreed to meet to discuss the dissertation research and pointed to the resources they have provided on their website. They were not recorded to ensure confidentiality. When asked about if graduate students in engineering utilized their services, they were adamant that they had helped many engineering graduate students, even doctoral students. They intimated that the skills and resources that undergraduates needed for a job search, interviewing, and networking were transferable to graduate students. They then challenged graduate students' notion that the advice from Career Services was not specific enough to help engineering doctoral students. More specifically, Career Services indicated that one strategy to assist graduate students is to parallel what they do as career coaches. They indicated that each student had unique career needs and that they had been trained to best help the individual. They also impressed the importance of networking and how websites like LinkedIn could be leveraged for highly specific contextual searches to find alumni with doctoral degrees in engineering. Finally, they brought up that faculty and research advisors can request presentations on specific career topics for their classes or research groups.

Upon further searching of Career Services webpages and resources, Career Fair guides allow students to search attending companies by whether they are searching for Ph.D.s, post Ph.D.s, and other graduate student roles. A quick search using AggieHandshake for 'engineering faculty' yielded job announcements for postdoctoral associates, assistant professors, and other higher education appointments. Career Services resources can be versatile and apply to engineering doctoral students. However, it is important to note that when looking at these resources and website materials there were no resources labeled as being specific to graduate student audiences at the time of this dissertation.

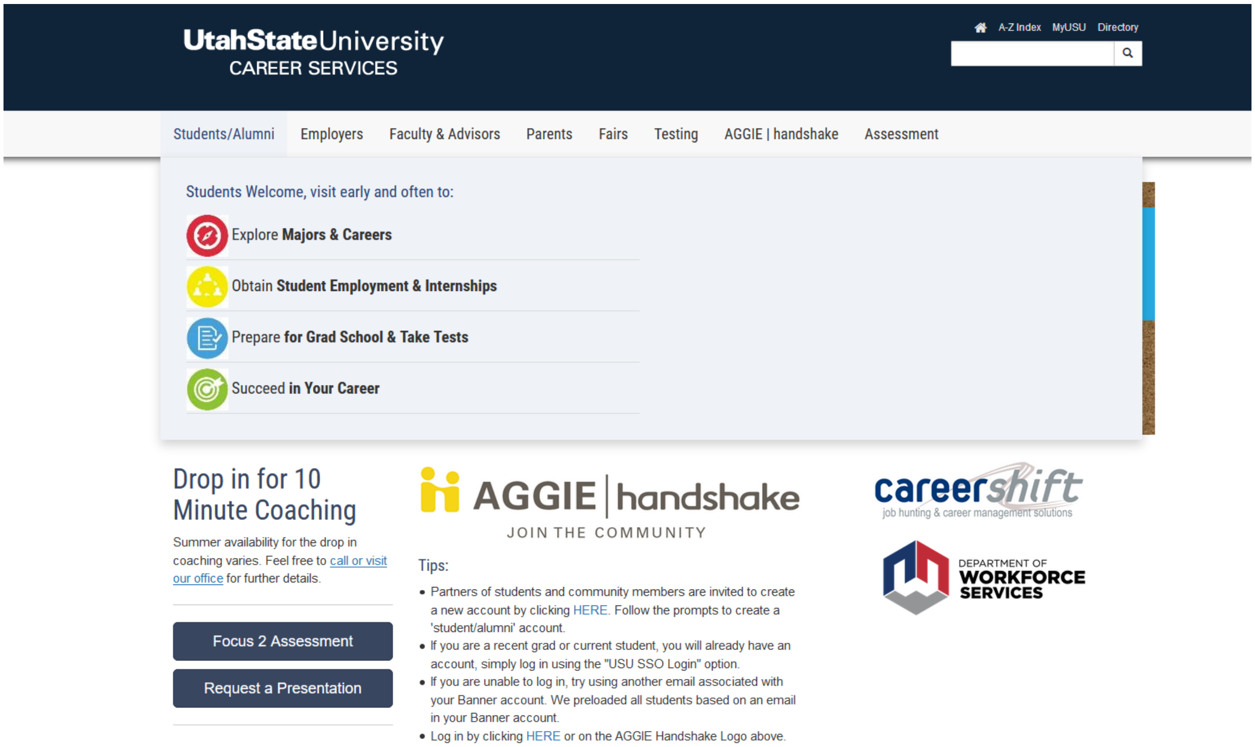


Figure 4-9. Example of Career Services webpage [accessed July 2019].

The majority of doctoral student participants brought up Graduate Training Series [GrTS] in their interviews so information specific to GrTS was solicited from staff via email. GrTS stood out from other career resources because of their focus on incorporating student feedback into their session content and scheduling. When asked about what factors went into selecting content of sessions, the staff responded:

> *We focus primarily on student feedback for selecting content. In addition to comment cards that we collect at the workshops, each summer we send out a survey to grad students, which includes questions about GrTS and what topics would be most useful to them. We also keep in mind gaps in student knowledge that we've gathered from other survey questions, faculty feedback, etc. Once we have an idea of what topics would be most beneficial, we seek out the best speakers for those topics.* (Staff #2, Email Line 11).

GrTS was originally created in response to a survey of current and potential graduate students and their "desire for value-added opportunities" and to socialize with other graduate students. While originally focused on research-based skills, they broadened the scope to "include any topic that would be of broad interest to a graduate student population, including career development, communication skills, and mental health resources." (Staff #2, Email Line 7). They use attendance comment cards, student surveys, a "like" or "dislike" box, and RSVP vs. attendance data to assess GrTS. When asked about their most highly rated or attended sessions, the staff responded:

> *Our most highly attended session so far this year has been "Tips for Successful Literature Reviews," last year was "Career Advice for Outside Academia." Career advice is always something grad students want more of, so these types of sessions are always highly attended. In past years, our most highly attended workshops were on designing slides and posters for academic conferences*. (Staff #2, Email Line 19).

Like the engineering doctoral participants, timing was also an important issue for staff to consider when offering career resources. When asked about the challenges associated with GrTS, the staff responded:

> *Timing will always be a challenge with GrTS. We hold the workshops Wednesday afternoons because we've found that that's the best time for many of our students, but there's no time slot when everyone who wants to attend will be available. We combat this issue by recording the sessions and posting the videos and summaries online, as well as making the workshops available via livestream to students who can't make it to campus. Additionally, it's a lot of work and preparation to provide good and engaging content for these workshops, especially since we generally don't repeat topics from year to year*. (Staff #2, Email Line 24).

This staff member is aware that issues of time are important for graduate students and not only uses considerations of graduate students to schedule their sessions, but also allows options for students to access their resources off-campus and at times that are more convenient. The staff stated that on average, they had the highest in-person attendance from the College of Engineering and the College of Education and Human Services.

Departmental staff were informally interviewed and were not recorded to ensure confidentiality. Engineering doctoral student participants did not list departmental staff specific to the College of Engineering as a source of support or career resource. One participant noted that they helped them fill out paperwork, but did not serve any other role. This aligned with what graduate programming coordinators (GPCs) thought of their specific role. Some did not see their role as relevant to career resources or skill development. One task they performed was forwarding job announcements or other relevant emails that might have relevant career resources to graduate students. One non-GPC departmental staff saw their role in relation towards graduate students as more nuanced. They related that graduate student recruitment was the most important topic for some departments and that this should mean they should be incentivized to keep graduate students. However, they remarked that the same recruitment and retention strategies were being used and that a concerted data collection effort had to be made to track graduate student recruitment and departure (e.g., tracking alumni careers). Such data collection efforts would have to have a dedicated staff member in order to be consistent. The staff participant’s believed that faculty and current graduate students were the best source for recruiting new students, which corroborated a similar finding of the doctoral student interviews. Lastly, the staff participant commented on the importance of “just-in-time training” for engineering doctoral students. The staff related that they could provide a variety of helpful resources and send emails to remind students, but unless they needed that resource immediately, they were likely to ignore it.

4.2.2.2 Library Staff

Inclusion of library staff into the potential staff participant pool occurred after they were specifically mentioned in a doctoral student participant’s interview. This staff participant was approached, and they agreed to be interviewed after an introductory session to discuss the dissertation Action Research. Upon initial email contact with the participant they remarked:

> *One thing I do is go into classes – like your own – and speak on different subjects ranging from using library materials and services, to finding and ordering standards, to avoiding predatory publishers, to navigating copyright and author rights legally. I’m meeting with two ENGR grad classes next week [...].* (Staff #1, Email Line 2).

At the formal interview, this participant was given the list of skills and competencies needed for engineering doctoral students for all careers and asked to read it. The staff participant underlined or highlighted skills that they believed they helped students develop. The staff member indicated that these skills could be applicable to engineering doctoral students as well as undergraduates. A summary of these skills is provided in Table 4-9. There were four types of skills that this staff participant stated they that they helped students develop. The staff participant particularly saw value in helping engineering students develop communication skills beyond writing papers. They stated:

> *[…] when I think of careers and engineers, I do wish that more students realized how great it is to have [technical] engineering skills coupled with communication skills. And I think as engineers, we're so focused on, you know, problem solving and, you know, different equations, or formulas, or standards that sometimes we lose the communication that is, like, makes you a really good candidate.* (Staff #1, Line 49).

The staff participant also mentioned that they gave advice to engineering graduate students about seeking academic careers, tenure, and citation metrics important for career advancement. They brought up the coded tactic of 'Marketing Self' in relation to the USU resource, Digital Commons. They said:

> *Yeah, to me digital commons is really about, like, marketing yourself and getting yourself out there because the website through which it's published is really well harvested by Google, which is great, so more people can discover it. It also gives you some citation metrics as far as... Sorry, this is the messiest ever. So, digital commons gives you citation metrics as far as how many downloads you have every month. So, even if you're not getting cited yet, if you're getting downloaded a bunch, you could kind of put that on a CV or something like that or mention it in a letter. So, if you're looking for a job at a, you know, institution, it might be good.* (Staff #1, Interview Line 73).

The participant was also asked to read through a list of Career Resources and mark any items they had ever assisted, provided, or shared information to graduate students about. They marked the following:

- Trainings or seminars on campus (e.g. GrTS)
- Departmental seminars with a focus on developing skills (e.g., literature search)
- Writing or research help
- Invited class guest speaker

Table 4-9. Skills that the library staff participant reported they could help students develop.

Type of Skill	Specifically Highlighted	Relevant Example
Technical	Techniques designed to conduct research effectively	Literature search strategies, information on predatory publishers
Communication	The ability to convey information to an audience	Written communication (reports, academic writing)
Communication	The ability to tailor information to non-academic audiences	In describing what they were searching for, graduate students were forced to tailor highly specific technical content in a way a librarian could understand
Teamwork and Collaboration	Trans-disciplinary contexts	Encourages collaborative skills through requiring students to slow down, explain the problem, and work together to find search-keywords
Organizational Culture and Ethics	Disciplinary values	Information about tenure, publication citation metrics
Economic and Commercial	Protecting intellectual property	Invited into classrooms to discuss patents and intellectual property

This staff participant was also aware of engineering graduate students' focus on saving time and their perception of provided resources. When asked what they wished graduate students knew about their role and what services they provided, they responded:

> *Well, first I just wish they knew that I existed, one. And I think hopefully, I've made headway in these 14 years and most of them do know that. But number two is probably that I can save them time. So, I would say in that case, it's the same as the undergraduates. I think students often don't come to me because they think they're too busy, and because I'm not in that position of grading them or sitting on their committees usually that they just don't see me as a helpful part of the process. So, I worry about that a little bit. So, I wish they knew that, if they came to me, I could probably save them a lot of time in the long run.* (Staff #1, Interview Line 45).

They also remarked that they were unsure about where engineering graduate students sought career information from, but they believed engineers tended to seek career information from other engineers. They said:

> *I think a lot of stuff, the engineers really do communicate with each other well about these things [i.e., career resources] or talk about these things, I hope at least. So, I think a lot of it is networking. So, the better you can network, it probably helps. Yeah. I'm really not sure beyond that.* (Staff #1, Interview Line 56).

4.2.3 Proximity to Doctoral Students

Synthesizing the discourse between university staff and engineering doctoral student participant perceptions resulted in several takeaways:

- Engineering doctoral participants were not aware of the full range of career options or functions that they could pursue with a Ph.D. upon entry into their programs. It was through experiential activities that they discovered what they wanted to do and were passionate about.

- Engineering doctoral student participants trust insiders to have the ability to help them pursue highly specific careers after attaining their Ph.D. and they expressed less confidence in more generalized career resources.
- To increase the perceived value to doctoral student participants, career resources need to be explicitly more contextual (e.g., specific to graduate students, specific to STEM doctoral students) and need to be accessible both by relative location and on the student's limited time.
- Career resources where staff expressed awareness of graduate students' limited time or an enhanced contextual understanding of what skills were specifically important for them to develop were highly regarded by doctoral student participants.

These takeaways build a case for the importance of proximity of career resources to engineering doctoral students. Proximity is a nearness in place, time, order, occurrence, or relatedness. This means that career resources need to be offered in relation with engineering doctoral students in time adaptive ways. The time that resources are offered needs to be determined through consideration of both the institution and the students. This is exemplified by the GrTS program and how they use student feedback to determine content and how and when they offer their programming. Proximity also needs to be considerate of the insider identity. When outsiders offer career resources, they need to be cognizant that even if those resources are useful and valuable that (without insider acceptance) they will be perceived as a poor fit. One staff participant exemplified this by going directly into Engineering classrooms which required an invitation by faculty. They said:

> *I think getting invitations into the classroom is always great because that says your professor thinks this is important enough that they actually took class time out for me to visit you, even if it's five minutes, you know. Sometimes it's longer than that and sometimes it's just five minutes, but I will take it*. (Staff #1, Interview Line 141).

When asked how others could help them provide resources to graduate students, they brought up the importance of presence and being visible:

> *I also just think partnering with professors and instructors, so they see me in classes sometimes is really important. So, working closely with the departments and getting my foot in there, like, I worry that I say the same over and over again when students see me. So, I worry that it can be repetitive. But I think it's good to keep in the awareness because I'm outside of the normal circle that graduate students...Like, they don't see me every day. Like, unless they come to the library every day. And most engineering students do not. Let's just admit it. You know, they just don't see me. I'm not at the front of their consciousness like an adviser or their chair to the...for their, you know, thesis committee would be. So, I think it's important to keep an awareness and however I can get in on that is pretty good.* (Staff #1, Interview Lines 91-92).

CHAPTER 5

DISCUSSION

A combination of two qualitative methodologies (i.e., Narrative Inquiry and Action Research) were utilized to explore the perceived career prospects and pursued sources of support and resources for domestic engineering doctoral students at Utah State University. The themes of Engineering Doctoral Identity, Engineering Doctoral Skill Development, and Time informed the discourse on perception, value, and utilization of career resources on campus. The following sections of this chapter will discuss the implications of this dissertation's results with a focus on Career Prospects, Identity and Fit, Skill Development over Time, Career Resource Utilization, and Potential Actions. These are summarized below.

When considering a future career, engineering doctoral student participants showed a preference for a career function (i.e., the specific tasks, activities, or routines of a job position), but were willing to consider a variety of different career sectors (e.g., academia, government, industry). Likewise, when considering their first job position after attaining a Ph.D., participants were flexible in the types of job-positions they would accept if they saw it as a stepping-stone towards a more ideal career. This preferred career function influenced what type of career resources participants sought out. For example, teaching-focused participants intentionally sought out career resources that would help them attain or enhance their teaching skills. However, certain career resources and opportunities were privileged over others through structural program enforcement (e.g., coursework, research assistantship) and implicit norms and expectations propagated through an Engineering Doctoral Identity.

Engineering Doctoral Identity was primarily defined and enforced by ‘insiders’, or people who had or were seeking a Ph.D. in an engineering field. These insiders placed a high value on research and its metrics of success at the expense of other functions such as teaching. Engineering doctoral student participants had to negotiate their fit between their preferred career function and the insider definition of engineering doctoral identity. When their preferred career function was aligned with the values of the engineering doctoral identity (i.e., research), participants perceived more support and opportunities to pursue relevant career development. However, participants still lacked sufficient opportunities to develop certain skills that are necessary for an academic research career (e.g., grant writing). This mismatch of identity and prioritization of technical research skills over others was exacerbated by limited time. Seeking out career development opportunities or resources as an investment in their future was often difficult when short-term objective deadlines and requirements were numerous and pressing. In response to the push and pull between preparing for a future career and the more immediate tasks necessary to attain a Ph.D., engineering doctoral students utilized Time Adaptive Tactics such as being flexible, networking, and using career resources.

Career resource perception, value, and utilization was influenced by the *context* of those resources (i.e., how specific they were to engineering doctoral students), and by their *proximity* (i.e., nearness in time, location, and relatedness). Graduate-student specific resources (e.g., Graduate Training Series) were more contextually relevant to engineering doctoral students and, thus, were perceived more favorably than resources offered through Career Services, which participants perceived to be not relevant to doctoral students. This perception was consistent across all engineering doctoral student participants regardless of phase of development (i.e., entry, integration, candidacy) and of intended career path. Proximity of resources was also important considering an engineering doctoral student's limited time. When resources were offered in a way that doctoral students could access on their own time or in multiple locations (e.g., recordings, broadcast), doctoral student perception of those resources increased, especially if they were contextually relevant. Proximity was also influenced by insiders who are typically spatially close to the doctoral student at all times. For example, research advisors typically act as supervisors for research assistantships, serve as the head of their dissertation committee, and guide the student through their programmatic requirements. They are proximal to the students in location (e.g., offices, labs), time (e.g., required tasks, meetings), and identity. Proximity of career resources can be increased through insiders who can signal approval of those resources by bringing them into classrooms, seminars, or other required activities.

There is a hierarchy of the perceived value of career resources based upon context and proximity of those resources to engineering doctoral students. Resources that are provided by insiders such as faculty are at the top of the hierarchy, while resources that are provided strictly by outsiders and are not contextually relevant are at the bottom. These resources can be useful to engineering doctoral students seeking all types of careers if they are flexible enough to utilize them. Insiders can take several actions to help engineering doctoral students utilize these resources for both academic and non-academic careers including inviting university staff to speak in their graduate classes, seminars, or research labs. In turn, university staff can also take several actions including becoming more cognizant of contextual career resource needs. While there is a potential for partnerships between faculty insiders and university staff outsiders to increase awareness and utilization of career resources to engineering doctoral students (or graduate students in general), there remains several systemic barriers to overcome. There is an often unstated but well understood preference for engineering doctoral students to pursue academic careers despite labor market conditions or personal preferences (Gardner, 2007). This preference for academic careers can result in a lack of awareness in different career options and the skills of how to pursue those types of careers (Denecke et al., 2017; Golde & Dore, 2001). Additionally, faculty or other insiders may worry that the quality of students may decrease or that dedicating time to broadening their students' skills will detract from their deadline-driven research projects (Akay, 2008). The current university funding structure, where the majority of engineering doctoral students are funded through their research advisor's grants, results in that advisor having the dual role of advisor and employer, which can potentially create a conflict of interest in promoting the student's best professional interest (Benderly, 2010). While several potential actions for students, staff, and faculty are presented in this chapter, this broader systemic issue will continue reinforce how doctoral students are trained and the emphasis on research and academic careers.

5.1 Career Prospects

The first research question of this dissertation sought to answer what career prospects domestic engineering doctoral students were considering. The participants that self-selected into this study predominantly considered academic careers. Eight out of nine participants were considering academic career paths, and only one had explicitly written off academia as a possible career path. However, participants showed flexibility both in the type of careers they would consider and job fit characteristics like work-life balance. The wide range of careers included government research institutions, industry, consultancy, and atypical careers such as a Federal Bureau of Investigation (FBI) agent or starting their own business. As long as the participant's future career somehow served the purpose of their primary preferred career function (e.g., job type, job tasks), most participants were willing to consider any career sector (e.g., academia, industry). Participants were also flexible in the types of jobs they would take immediately after receiving a Ph.D. as long as that job could be used as a stepping-stone to a more desirable career. This flexibility in career choice may be necessary due to market conditions (Conti & Visentin, 2015) and/or doctoral students being unprepared for their chosen careers, including academia (Berdanier et al., 2014; Denecke et al., 2017; NASEM, 2018).

Participants were inflexible in their preferred career function and certain job-fit characteristics. Participants preferred career functions were broken into four types for the nine participants: (1) Research; (2) Teaching; (3) Service; and (4) Engineering. Three out of four of these functions represent the core aspects of an academic career, which aligns well with the result that the majority of participants were considering academic careers. The last function of Engineering emerged after analyzing DS #3's responses and not being able to classify them among the primary academic roles. After member checking with this participant, they described their career function as the "practical application of research". DS #3's responses were re-analyzed in their context of being employed in engineering-industry and 'Engineering' was selected as the most appropriate primary career function. A summary of participants' preferred career function is provided in Figure 5-1.

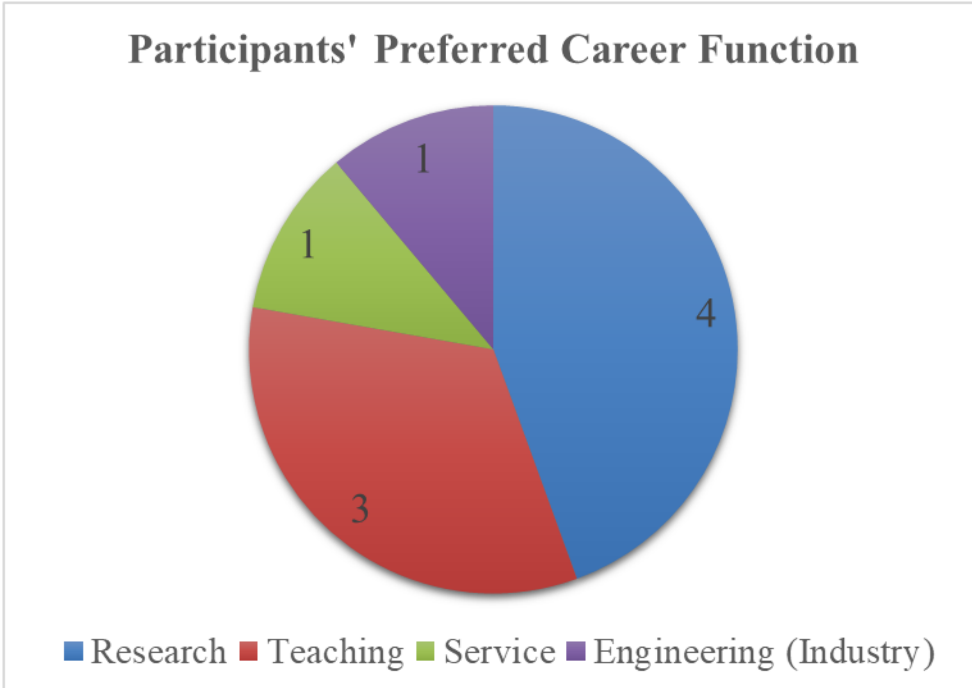


Figure 5-1. Participants' preferred career function.

The four research-focused participants saw many potential career prospects beyond academia and were willing to consider them. They felt well suited for careers in government, industry, and academia. Despite the implicit and explicit focus on research in their doctoral programs, five out of the nine participants preferred other career functions such as teaching to research. Teaching focused participants were aware that their departments did not value teaching to the degree that they valued research, but they still preferred to have a tenure-track academic position at a research-intensive institution. Of these teaching-focused participants, only one (DS #4) explicitly expressed strict unwillingness to incorporate research into their career. The other two participants (DS #1, DS #2) were willing to conduct research if it brought them more influence or acceptance within their fields. The service-focused participant (DS #5) saw research as an integral part of their career and research would ultimately lead to helping others. Upon member checking, DS #5 revealed they had secured employment with a government agency conducting research rather than academia. While DS #5 admitted this was not their original plan, they were confident they could still meet their long-term career goals of helping others (i.e., service), but it would take much longer than expected.

Seven out of nine participants expressed flexibility in career sector (e.g., academia, industry). This flexibility, however, had a corresponding inflexibility in other aspects of employment such as job-fit characteristics that they did not want to compromise on. These preferred job-fit characteristics predominantly winnowed to the type of job (i.e., primary career function) and work-life balance and characteristics associated with it (e.g., location, family considerations). This could possibly be attributed to cultural factors and the participants' high value and priority of family. Six out of nine participants had children or explicitly expressed interest in having children during their interviews without being prompted. Of the remaining three participants, only one listed work-life balance as an important job fit characteristic and it was in reference to having a personal life, not balancing work with family. Member checking with seven out of nine participants revealed they all believed that flexibility was important in the types of careers they considered. DS#5 described how being flexible in certain areas allowed for inflexibility in others. Participants struggled to articulate their career choice and job fit priorities because these decisions involved aspects of their entire lives, rather than simply the tasks they had to perform in their job. This may explain participants' often contradictory statements on the importance of salary. While only two participants explicitly listed salary and benefits as an important employment quality consideration, their description and definitions of engineers with Ph.D.s mentioned that they started at a higher pay than engineers with a B.S. degree. They additionally weighed the time and financial costs of pursuing a Ph.D. versus the potential benefits. A higher salary was implicitly expected due to the prestige of having a Ph.D. This may explain why the majority (72.9%) of engineering doctorate recipients report non-academic commitments immediately after receiving their Ph.D. (NCSES, 2018). The average salary of recent engineering Ph.D. recipients (less than 5 years after a doctorate) is much greater for industry ($104,000) and government ($98,000) than in tenure-track positions at four-year institutions ($83,000) (NSB, 2018). This disparity is exacerbated if the Ph.D. recipient takes a post-doctoral position first, which has an average salary of $48,000 (NSB, 2018). At the same time, the percentage of engineering Ph.D.s who take temporary post-doctoral positions has risen from 4.0% in 2003 to 5.5% in 2015 (NSB, 2018). After investing time into a Ph.D. program that could have been spent earning a salary as an engineer (Howell-Smith, 2011), engineering doctorate recipients may view the possibility of a more lucrative starting salary in government or industry as a better fit with their life, especially if they are more flexible in career sector.

5.2 Skill Development Over Time

The second research question of this dissertation sought to answer how different career prospects influenced the types of resources engineering doctoral students pursued. It was expected that there would be a difference in the career resources pursued or not pursued by academic vs. non-academic career seeking participants. While this held true for the type of skills that doctoral student participants reported developing, the academic vs. non-academic dichotomy was more nuanced when considering participants' preferred career function. Participants reported developing many of the skills associated with academic careers. However, skills associated with research (e.g., technical, working independently) were reinforced over others (e.g., teaching), and participants did not show awareness of the importance of other necessary skills (e.g., economic and commercial skills).

Doctoral student participants showed a high awareness of and opportunity to develop many of the skills that are necessary for a career in academia, which is consistent with literature (Berdanier et al., 2014; Denecke et al., 2017; Watson & Lyons, 2011). Despite this, the participants generally noted that they did not have enough time to develop certain skills necessary to be successful academics. For example, doctoral candidates and recent graduates remarked on their lack of publications during their time as a student because of how long it took publish. They perceived that a lack of publications would negatively affect their chances of being hired in academic careers. Participants who were seeking academic careers but preferred teaching- and service-functions perceived gaps and a lack of opportunity to develop their teaching skills. Despite showing a high awareness of some of the skills needed to be a successful academic (e.g., technical, communication, working independently), few participants mentioned that economic and commercial, teamwork and collaboration, and interpersonal skills were important for their intended careers. For example, creating a budget is a critical part of applying to grants necessary for research. However, there were no participants who mentioned creating a budget in their interviews. Similarly, Watson and Lyons' (2011) study of engineering Ph.D.s in non-academic fields found that engineering doctoral recipients felt underprepared for similar types of skills (e.g., working in teams, understanding intellectual property processes, and identifying customer needs). While skills associated with academic careers were developed by participants, the results indicated that certain skills are valued over others.

Many participants in this study expressed frustration over the lack of opportunities to develop teaching skills and an emphasis on developing technical (i.e., research) skills. Even participants not interested in teaching skills expressed how research was not only valued but also central to the identity of having a doctorate in their fields. Opportunities to develop skills and aptitudes associated with conducting research (e.g., technical, critical and analytical thinking, problem solving, working independently, writing conference papers and publications) had systemic and financial reinforcement through degree requirements and assistantships. On the other hand, opportunities to develop skills that were not as valued as research (e.g., teaching skills) were left up to the individual participants to pursue on their own time. This supports the assertion that doctoral students are “primarily prepared to become faculty members who focus much of their energy on research” (Golde & Dore, 2001, p.12). When participants pursued non-research professional development opportunities and career resources, their choice was reliant on:

- Awareness of the type of careers available for engineering Ph.D. recipients and the requisite skills that are required and valued in those careers.
- Awareness and existence of corresponding professional development opportunities to develop skills for their intended careers.
- Time to pursue those professional development opportunities.

This combination of factors is often reliant on a student’s agency within their departments and personal lives (Gardner, 2008). Previous research has shown that students who want to pursue faculty positions report feeling more agency than students who want to pursue non-academic positions because they have more career-specific information, support, and faculty role models (Gardner, 2010b; Golde, 2005). However, this previous research does not delineate between the specific career function doctoral students prefer (e.g., teaching) and instead focuses broadly on academic vs. non-academic careers. Even if doctoral students are pursuing academic careers, they may not feel they have the agency to develop teaching or other aspects of an academic career during their doctoral study without the necessary resources and support from their departments. In one study, STEM doctoral students felt more agency in achieving their career goals when "tangible resources" such as information about professional development resources were provided by their department (O'Meara et al., 2014, p. 169). Another study of over 5,000 doctoral programs at 212 universities found that providing STEM doctoral students with training in writing and teaching were positively associated with doctoral completion (Zhou & Okahana, 2019).

For doctoral student participants, some were unaware of what opportunities existed while others simply struggled to find the time to pursue those opportunities—especially if opportunities were not explicitly related to research. If participants were aware, they still had to self-advocate to pursue those opportunities, especially if they were dependent on departmental or research-advisor approval. Before self-advocating actions could be considered, participants engaged in a circular negotiation of their time and resources. They made decisions to allocate time to professional development in the most optimal and efficient way they could by weighing the short-term time costs versus long-term career benefits. This time-optimization, however, was influenced by value judgments influenced by faculty and departments (i.e., insiders) who have significant influence over their objective day-to-day allocations of time.

Creating time for professional development opportunities required participants to be aware of these insider values and possible repercussions of not meeting more immediate deadlines if they sought future development instead. The participants had several approaches on how they handled conflicting time demands. These were:

1. Strictly focused on immediate degree requirements at the potential cost of not being an attractive job-candidate because of other conflicting personal roles or demands.
2. Optimized their limited time in the most efficient way possible by selecting professional development opportunities or career resources that offered the most benefit for the cost.
3. Created time for professional development opportunities by pushing back on more immediate degree requirements.

These approaches reflect two perceptions or experiences of time in the context of goal setting: (1) Objective Time and (2) Subjective Time (Fried & Slowik, 2004). Goal setting theory simply states that an individual's behavior is based upon conscious goals and intentions and that positive outcomes of goals will be high if those goals are challenging, specific, and attainable (Locke & Lantham, 2002). The engineering doctoral students all had various objectives, but generally they wanted to receive their Ph.D. and be employed after graduation. Challenging goals, such as getting a Ph.D., require the creation of a hierarchy of goals. This hierarchy requires individuals to pursue less challenging sub-goals, which will help them meet their more difficult overarching goal

(Fried & Slowik, 2004). This means that the participants were negotiating between their own hierarchy of goals by balancing attainable tasks (i.e., objective time) that could contribute to a future goal (i.e., subjective time). The subjective definition of present and future time is influenced by occupational norms (Fried & Slowik, 2004), which indicates that insider values and practices influence how the doctoral student participants approached their tasks.

Both subjective and objective experiences of time were an unavoidable reality for the participants. Objective deadlines and time spent negotiating their various professional roles (e.g., doctoral student, research assistant) and personal roles (e.g., spouse, parent) are built systematically into day-to-day life. However, participants were clearly considering conceptualizations of their future careers before and during their doctoral student experience. Considering the short-term vs. long-term benefits of any experience (e.g., professional development, dissertation research) and allocating time based upon that analysis is something participants decided for themselves. However, a focus strictly on objective time or subjective time at the expense of the other can be potentially detrimental. Research on mental health of graduate students indicates that inter-role conflict (i.e., the difficulties and strain that arise from meeting different expectations from various professional and personal roles) is one of the main sources of stress in graduate students (Benshoff, Cashwell, & Rowell, 2015; Grady, La Touche, Oslawski-Lopez, Powers, & Simacek, 2014). Levecque and colleagues similarly found that balancing doctoral student work and family was the most important predictor of psychological distress for Ph.D. students in Belgium (Levecque et al., 2017). Different roles (e.g., spouse, research assistant, teaching assistant) all require objective day-to-day time allocations, prompting the development of time management skills to cope. Conceptions of future role (i.e., their future career) could be creating an intersecting layer of inter-role conflict based upon conflicts between objective and subjective time.

In order to counteract the strain of balancing objective and subjective time, participants developed several tactics to balance both present and future needs (i.e., Time Adaptive Tactics). The three tactics described were: (1) Flexibility; (2) Networking; and (3) Using Career Resources. By employing these tactics, participants balance working towards their more challenging future goals while still focusing on present tasks. Faculty and staff can play a role in helping doctoral students utilize these tactics and also by being flexible. For example, the GrTS seminars were scheduled using student input and there were multiple ways to access these resources synchronously and asynchronously. By being flexible, they expanded their proximity to graduate students through offering resources independent of location and time.

All participants had to balance objective and subjective time, but doctoral candidates had the additional burden of balancing the needs of future employers who may wish to hire them on timelines that are not aligned with theirs. As they transition out of their doctoral programs, they are once again beholden to issues of timing (or ‘time fit’) with their degree progress and future employers. To counter this, doctoral candidates must be flexible in what positions they apply to and accept. Doctoral candidates can be flexible both in type of job and job-fit characteristics. If they actively reframe less desirable job-fit characteristics in a positive way, they can actively shape their future goals. For example, many participants wanted a healthy work-life balance that gave them time with their families. Participants pursuing academic careers mentioned that the independence associated with academia aligned with their preference for a healthy work-life balance. This is seemingly contradictory to literature suggesting that graduate students' perceptions of intense demands associated with seeking tenure are incongruent with a healthy work-life balance (Mason, Goulden, & Frasch, 2009). A recent study found that engineering and computer science doctoral students and recent graduates perceived that the pursuit of a healthy work-life balance in academia seemed to be an "impossible goal" (McGee et al., 2019 p. 294). Despite this, the majority of participants in this dissertation research who were seeking academic careers focused on the positive attributes of academia (e.g., the ability to work independently and set their own schedules) rather than aspects of academia that could produce an unhealthy work-life balance.

5.3 Identity and Fit

This dissertation used the Theory of Doctoral Student Development (Gardner, 2009), and Person-Vocation (PV) Fit in the context of doctoral study (Baker & Pifer, 2015) as a theoretical framework. The combination of these frameworks surmised that doctoral students will successfully navigate their doctoral experience over time if they have enough supports (i.e., resources) to meet the various challenges of their program (Gardner, 2009). Also, if doctoral students perceived a better fit between them and their intended vocation, they would engage in professional development and become a better candidate for future employment (Baker & Pifer, 2015). Research has shown that if doctoral students perceive they do not fit with their department or discipline, they are likely to withdraw from the program (Golde, 2005). This greater perceived fit between the individual student and their chosen vocation (i.e., PV fit) would act as a support to buffer the challenges of doctoral study and therefore enhance their development. However, PV fit acted as both a support and a challenge for the participants. Their perceived fit was influenced by their conceptualization and negotiation of an Engineering Doctoral Identity. Insiders who determined what is valued and rewarded primarily defined this identity.

Identity is an integral aspect of several higher education student development models (Chickering & Reisser, 1993; Erickson, 1968; McEwen, 2005). The intersection of engineering and academic insider (e.g., faculty) identity in contrast to outsiders (i.e., those without a Ph.D.) highlighted an important challenge for engineering doctoral students—negotiation of fit. Faculty conceptions of what it means to be a researcher or an academic can be misaligned with their graduate students (Bieber & Worley, 2006). The participants in this study revealed conflicting career-function preferences (e.g., preferring teaching over research) and time related tensions in pursuing professional development related to misaligned career functions. While participants related that their research advisors were not opposed to pursuing outside opportunities, they were not actively supportive. These types of messages can communicate hidden expectations and norms such as an expectation to pursue academic careers (Gelles, Villanueva, & Di Stefano., 2018; Lovitts, 2007). Correspondingly, these expectations are reinforced by program requirements and research assistantships that are required to receive a Ph.D. (Golde, 2005).

It is also important to note that the phases of Gardner's theory of Doctoral Student Development (like Chickering & Reisser's theory) are not rigidly sequential and allow for students to move back and forth through phases (Gardner, 2009) or vectors

(Chickering & Reisser, 1993) at different rates. This indicates that an individual's development requires a more subjective than objective interpretation of time. The engineering doctoral student participants also did not experience time in a strictly linear or objective manner. They constantly had to reconcile their experiences of time with their respective roles and identities, which can be incongruous to the objective time requirements of research, the university, and employers.

5.3.1 Intersection of Engineering and Doctoral Identities

Doctoral student development is intertwined with graduate student socialization processes (Gardner, 2009). Development of graduate students involves concurrent socialization processes, both as students and in preparation for their future careers (Golde, 1998). Likewise, Gardner's theory describes how a doctoral student's identity shifts and changes as they construct a professional identity from their student identity (Gardner, 2009). One aspect of identity development is that of role identity, which considers the multiple and sometimes competing identities individuals have as they categorize or associate themselves with a particular group (McCall, 2003). Role identity is co-constructed by the expectations and actions of others who are currently in that role (e.g., academic insider) and the individual developing the role identity who reacts to those actions and expectations (Stets & Harrod, 2004; Hall & Burns, 2009). Role-identity development is a continuous process of negotiation that requires both validation and legitimatization by insiders within that role and involves self-verification by the individual (Gee, 2000; McCall, 2003). Research has shown that doctoral students continuously oscillate between these various roles such as research assistant and aspiring professional throughout their doctoral student experience (Jazvac-Martek, 2009). The doctoral student participants revealed the development of a doctoral (i.e., insider) role-identity through their awareness of research being central to that identity and the relative lack of value for other functions such as teaching. Participants knew and internalized the metrics of success in academia such as publishing and were willing to perform these tasks, even if they were not in alignment with their preferred career function. Doctoral students who align themselves and seek up activities that are valued by those who have defined their identity, will be perceived as more successful and those who do not or resist will be risk of being marginalized (Hall & Burns, 2009).

The doctoral identity that participants were developing throughout the phases of their program combined and intersected with a professional engineering role-identity to form a new identity, the Engineering Doctoral Identity. Aspects of an engineering role-identity emerged in participants' formalized values related to optimizing their tasks and being as efficient as possible (Perkins et al., 2017; Villanueva & Nadelson, 2017). They had the same expectation that the hard work and difficulty associated with their degree would pay off with a higher salary (Villanueva, Mejía, & Revelo, 2018). They also valued the same aptitudes that are associated with engineers: design, innovation, problem solving, and prestige, similar to the historical underpinnings present in engineering curriculum (Godfrey & Parker, 2010; Villanueva & Nadelson, 2017). However, in their new Engineering Doctoral Student role, they began to redefine an engineering identity for engineers without Ph.D.s. When comparing engineers with a Ph.D. to engineers without a Ph.D., many participants redefined them as doing "routine" work or being technicians. In contrast, research on engineering identity suggests that students tend to focus on the creative, innovative, practicality of applications of math and science, and design as defining characteristics of engineers—definitions that do not fully encompass the traits of a 21st century engineer (Villanueva & Nadelson, 2017). However, these prestigious aptitudes were now conferred to engineers with Ph.D.s while engineers without Ph.D.s were, in a sense, demoted. Participants created an Engineering Doctoral Identity that centered on research and the values and aptitudes associated with it. These aptitudes, which are shared within engineering (e.g., critical and analytical thinking, problem solving, attention to detail, technical prowess), became the province of engineers with Ph.D.s. One participant, who had worked in engineering before and during their doctoral student experience, did not redefine an engineering identity as conducting routine work. Instead, the participant defined the Engineering Doctoral Identity as being a leader within the field of engineering who was more autonomous rather than focusing on their ability to research. This suggests that this participant's engineering role-identity was more developed—and more resistant to being redefined—than the other participants because of their experience as an engineer. More research on graduate students with industry experience prior to pursuing a doctoral degree may help shed more light on this finding.

What this insinuates is that the research-focused identity, which is defined and reinforced by insiders, can co-opt other identities. This has implications for the PV fit of engineering doctoral students. In their seminal report on the socialization of graduate and professional students in higher education, Weidman and colleagues reported that student professional identity conflicts can be exacerbated when graduate programs emphasize conflicting vocational norms, leading to a vocational identity crisis (Weidman et al., 2001). Participants interested in teaching-focused careers struggled to find actively supported opportunities to develop their teaching skills. Though they acknowledged that these skills were not valued by insiders and that faculty and others had advised them to focus on publications or other metrics of research success, they actively sought to develop them because those skills were critical to their intended vocation. Baker and Pifer proposed that the negative possible outcomes of PV misfit were failure to obtain desired employment, failure to succeed in professional role, and failure to obtain relevant support or training for career goals (2015). At the time the interviews were conducted, two participants who identified wanting service- or engineering-focused careers had completed their dissertation defenses but had not secured employment yet. This indicates that the vocational norms that engineering doctoral programs engrain in their students may have been at odds with the participants PV fit with their intended careers. Put simply, insiders (e.g., faculty) had a different conception of PV fit than the participants, which manifested in the engineering doctoral academic culture. Baker and Pifer proposed that this misfit would lead to negative outcomes such as lack of academic progress or professional development (Baker & Pifer, 2015). This was exemplified by DS #1, whose vocational interests were not exactly aligned with the academic culture of research. DS #1's academic progress was affected when they had to adjust their program of study several times to take additional classes that would contribute to developing teaching skills. While participants were not explicitly prevented from seeking out non-research professional development opportunities, they were not actively supported or given resources by their departments to pursue them.

What has not been considered in Baker and Pifer's theory and more recent work (Ward & Brennan, 2018), is the importance of 'timing' as a measure of fit. Timing was an important factor in doctoral student recruitment and in finding employment post Ph.D.

A participant's decision to pursue a Ph.D. was motivated by intrinsic interest (PV fit), timing (e.g., transitions), financial support (e.g., grant or fellowship) and faculty personally approaching them. Almost all of the participants mentioned that an insider individually encouraged them to pursue a Ph.D. The insider not only made them aware of the option of pursuing a doctoral degree, but also gave them the confidence and often provided the financial resources (e.g., assistantship) to do so. Participants entering doctoral programs mentioned fellowships or other financial supports that were available at an optimal career transition point in their life. Other participants had an intrinsic interest in research from previous undergraduate or master's degree experiences, but those opportunities were often facilitated by faculty insiders as well. In a qualitative study of library and information science doctoral students, intrinsic motivation and faculty played a role in how doctoral students are recruited (Hands, 2018). However, no literature could be found on how faculty decide to actively recruit doctoral students. These recruitment decisions could be related to personality factors that drive informal mentoring interactions (Johnson, 2016) or how faculty perceive the student would 'fit' within the culture of research. Further research needs to explore what fit factors faculty are using to recruit undergraduate or master's students into doctoral programs.

5.4 Career Resource Utilization

The discourse between engineering doctoral students and the resources they were using or not using revealed several takeaways:

- The career resources offered on campus can be valuable to *all* types of students seeking *all* types of careers.

- Not all resources are being utilized in the same way by engineering doctoral students. The engineering doctoral students had a clear preference for what resources they utilized and which they ignored.
- Staff providing these resources can better reach engineering doctoral students by increasing the level of context of these resources (e.g., being more specific to STEM doctoral careers), being intentionally inclusive of graduate students on marketing materials such as webpages (Lehker & Furlong, 2006), and offering multiple ways to access these resources that are independent of location and time (e.g., broadcasting, online recordings).
- Most importantly, staff must meet engineering doctoral students within their own contexts by being invited into their proximal space by 'Insiders' who implicitly signal their value to doctoral students. If staff are not invited and vetted by insiders, doctoral students will internalize the message that these resources are not valuable to them as future doctorates.

These takeaways indicate there is a hierarchy of resources, which are based upon the cultural norms and values of insiders. The perceived value and utility of a career resource increases with greater context (i.e., specificity of the resource to engineering doctoral students) and greater proximity (i.e., acceptance of insiders). A summary of this hierarchy is provided in Figure 5-2.

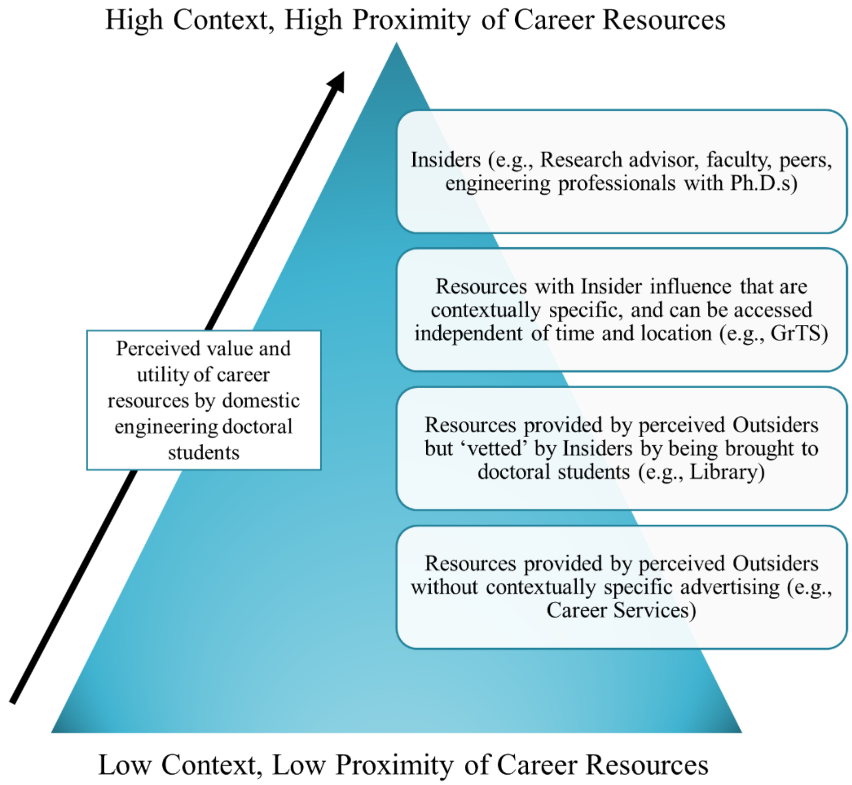


Figure 5-2. Hierarchy of Career Resources perceived by domestic engineering doctoral students.

Resources such as Career Services offered a convenient way for faculty to request presentations on specific subjects that could be tailored to the needs of students. They partnered with GrTS to offer sessions on interviewing, attaining faculty positions, and careers outside of academia which all had high attendance. Despite this, Career Services was not invited into graduate engineering classes while Library resources were. This extended invitation to Library services is likely because the resources they offer are relevant specifically to research (e.g., literature searches, citation metrics, identifying predatory journals). Thematic analysis indicated that research was central to participant perceptions of doctoral identity. Bringing in outsiders who provide career resources specific only to research skills and aptitudes reinforces the academic culture of valuing research over other career functions such as teaching or service. This is an example of a hidden curriculum within engineering doctoral programs. Hidden curriculum are the unwritten, unofficial, and unintended values and perspectives made by individuals and found in physical and virtual spaces within an academic environment (Giroux & Penna, 1979; Margolis & Romero, 1998; Portelli, 1993). Hidden curriculum in engineering could operate through implicit mechanisms or explicit pathways, with an (un)intentionality in the messaging that may guide an individual's decision to take (or not take) action through self-advocacy (Villanueva, Gelles, et al. 2018). A dissertation studying hidden curriculum in doctoral programs also showed that research was valued over other skills and activities (Foot, 2017). According to Foot:

> *Hidden curricula communicated messages about the types of knowledge valued in the program, the appropriate ways to create and disseminate knowledge in the academy, the social structures surrounding relationships in the academy, and the ways each participant's self might impact the doctoral curriculum*. (Foot, 2017 p. 163)

Additionally, hidden curriculum can potentially discourage Ph.D. students from seeking out academic careers. In a study of 147 engineering and computer science doctoral students, 69% of participants reported that institutional norms that emphasize research were a factor in not wanting to pursue academic careers (McGee et al., 2019). Furthermore, Roach and Sauermann found that STEM doctoral students' declining interest in academic careers was due to a change in preference of specific job attributes (e.g., applied research over basic research) and their perceptions of academic careers.

While it is likely not the intention of individual faculty to devalue some career resources, they may still send implicit messages about what is valued by who they invite and do not invite to meet their doctoral students. This could be especially important for students who did not get their undergraduate degree at the same institution as their doctoral study (e.g., out of state doctoral students, international students). Participants who had received their undergraduate degree at the same institution expressed the value of resources such as Career Services prior to their doctoral degree even if they did not utilize them now. Participants without that undergraduate experience were not aware of what resources were offered and internalized the discourse that these resources were unable to help doctoral students. GrTS already had a tactic to get around this. They offered content specific to graduate students with considerations of doctoral students' limited time and multiple ways to access the content synchronously or asynchronously. GrTS also employed an alternative tactic of bringing insiders to graduate students through including faculty guest speakers. They brought outsiders (e.g., Career Services) into their sessions and were able to provide valuable outsider resources that were contextual to graduate student specific needs. With the strategy of offering contextual resources and increasing proximity, GrTS intertwined insider and outsider resources in accessible ways that appealed to the engineering doctoral participants.

5.5 Potential Stakeholder Actions

This dissertation explored the career prospects and resources of engineering doctoral students using qualitative data from engineering doctoral students and university staff who have professional responsibilities towards graduate students. The results indicate that engineering doctoral students are more likely to trust career advice from insiders like their research advisor. Thus, faculty and other insiders are an integral part of providing professional support to engineering doctoral students pursuing all types of careers and non-research career functions. After an analysis of student and staff participant data, faculty and other academic insiders emerged as a critical stakeholder in the career development needs of engineering doctoral students. This is not an unexpected finding considering that research advisors who act as mentors to their graduate students are critical to their future professional success (King, 2003; Johnson, 2016). Each of these stakeholders (i.e., insiders, outsiders, and doctoral students) can take respective action to contribute to the professional success of engineering doctoral students. A summary of these potential actions is provided in Table 5-1.

Table 5-1 is not an exhaustive list of actions, but rather provides a starting point for insiders, outsiders, and students. Furthermore, these actions assume that insiders, outsiders, and doctoral students are invested enough and value taking action that may run counter to systemic barriers and entrenched attitudes about the purpose and outcomes of doctoral education. While engineering doctoral students have complex career-related motivations for pursuing a doctorate, the systemic drivers of engineering doctoral student recruitment are related to teaching and research assistant roles (i.e., total undergraduate enrollment, enrollment of undergraduates in a specific major, total sponsored research, and current graduate student enrollment) (Goldman & Massy, 2001). In essence, doctoral students are hired to fulfill a department’s teaching and research needs, which allow its faculty members to be more productive researchers.

Table 5-1. Summary of potential actions for insiders, outsiders, and engineering doctoral students.

Potential Insider (e.g., Faculty) Actions	**Potential Outsider (e.g., Career Services) Actions**	**Potential Engineering Doctoral Student Actions**
1. Ask their students what types of careers they are interested in at all stages of doctoral student development and offer advice on how to seek professional development.	1. Be cognizant that engineering doctoral students have highly specific needs and limited time to pursue professional development.	1. Self-assess, reflect on, and communicate their preferred career function and job fit characteristics to a trusted mentor, and research potential careers prospects.
2. Become aware of the breadth of career resources the university offers and how those resources could benefit their graduate students.	2. Market resources specifically to graduate students or doctoral students (the more specific the better).	2. Research and explore the skills necessary for their preferred career function and seek out corresponding professional opportunities and career resources.
3. Encourage students to be flexible in the types of jobs they consider, use existing connections to help students find professional development and employment, and offer career resources for all types of careers.	3. Offer career resources that consider student preferences and offer multiple ways to access these resources that are independent of time or location (e.g., GrTS).	3. Utilize a variety of tactics (Table C-5) that are most applicable to their unique situation.
4. Invite university staff such as Career Services into classrooms, seminars, or to speak with their research labs to convey that they offer valuable resources.	4. Be proactive about creating connections and relationships with faculty Insiders so that Insiders are aware of what they can offer.	4. Negotiate objective and subjective time by using Time Adaptive Tactics (i.e., flexibility, networking, using career resources)

Faculty may have conflicting views about what careers their doctoral students pursue, preferring that the students they advised and mentored pursue a career similar to their own (Gardner, 2007). Faculty, however, play the central role in “fostering the next generation of STEM professionals through their roles as educators, mentors, and advisors” (NASEM, 2018 p. 119). The importance of faculty mentoring to a graduate student’s professional development cannot be understated. In a study of science and engineering faculty and graduate students, both faculty and graduate students unequivocally acknowledged and understood the importance of the ethical mentoring principle of Beneficence (i.e., obligation to promote best professional interests) (Gelles et al., 2019). At the same time, graduate students expressed the normalcy of a research-advisor expecting their students to pursue academic career despite all faculty participants articulating that this presented an ethical issue (Gelles, Villanueva, & Di Stefano, 2018).

The National Academies of Science, Engineering, and Medicine have called for systemic cultural changes to graduate student STEM education to become more student centric and place equal value on all types of careers students pursue (NASEM, 2018). Despite this need for change, there are several enduring barriers to new models of engineering doctoral education (Akay, 2008). By providing counterpoints to arguments against change faculty or others might make, individuals may recognize value in changing their individual practices in relation to engineering doctoral students. These barriers and proposed counterpoints are summarized in Table 5-2. Despite faculty’s important role in the professional development of engineering doctoral students, faculty cannot possibly address all of these barriers alone. Systemic changes such as funding mechanisms and incentive structures need to be re-examined to facilitate changes in practice for individual faculty (NASEM, 2018).

Table 5-2. Summary of barriers to making changes in engineering doctoral student education models (Adapted from Akay, 2008).

Barrier	**Description of Barrier**	**Proposed Counterpoint**
Loss of Technical Content	Any activity outside of research dilutes the technical content of the degree.	Depth does not need to be sacrificed for breadth. Modern research and engineering is becoming more interdisciplinary and the current model of isolated specialization makes students unsuited for how research or engineering work is actually conducted.
Loss of Desirable Students	The best students self-select into engineering doctoral programs. Broadening engineering doctoral programs would result in less desirable students.	Expanding engineering Ph.D. programs would attract a larger pool of talented students. When students can see a connection between their doctoral student role and their future career plans, they are less likely to drop out.
Loss of Focus on Research	Time spent broadening a student’s education takes away student time from deadline-driven research projects. Research also funds tuition and stipend of Ph.D. students	Education goes beyond coursework and research. Students can balance their time between producing research and pursuing other interests and enrich their research with insights gained from those experiences.
Loss of Research Dollars	There is no incentive to change the current funding model for doctoral students., resulting in a research advisor being both advisor *and* employer. This can create conflicts of interest for promoting the student's professional success.	Research funds would have to shift or give equal emphasis to educating engineering graduate students rather than meeting research goals. The need to produce engineering doctorates capable of competing in today's context is greater than immediate research goals and deadlines.

5.6 Limitations

This study is limited in that it is conducted on a narrow population at one research-intensive institution within the Western United States. The results of this study are not generalizable all institutions of higher education. However, the findings of this study can be transferable to other institutions and engineering doctoral students. The strength of qualitative research is within its highly contextual and rich information (Creswell, 2013), which I believe this dissertation captured. Additionally, Action Research is only applicable within the single context that it is conducted (Herr & Anderson, 2015). The Action Research aspect of this study was limited by the relatively short duration of a doctoral dissertation in the context of staff careers and institutional history. Graduate education, being inherently liminal, limits the scope of action to a snapshot in time. Additionally, the level of trust and access granted to myself as a researcher by potential Action Research partners was highly dependent on my previous relationship with staff before my research began. Thus, the richness of discursive insight may have been influenced by the level of rapport I had with staff going into the research. Like the doctoral student participants, I had never accessed Career Services or spoken with their staff before, which could have affected my level of access. Additionally, I encountered difficulty in keeping rapport with Career Services due to personnel changes. The Action Research component of this dissertation was also, ironically, exacerbated by my own balancing of present degree requirements and future career goals. I pursued a four-month internship with a policy think-tank in the middle of my dissertation research that impeded my proximity to Action Research partners (and thus effectiveness).

The use of a transcription service, which provides quick and accurate transcripts of interviews, can often leave out contextual and non-verbatim clues and insights. While these transcriptions were amended to ensure transcription consistency with interview recordings, visual (e.g., facial expressions) and tonal clues (e.g., nervousness) were left out by necessity and in the interest of time. This could have limited the accuracy of the discourse analysis.

This dissertation was also limited by the small participant population that could be sampled from. In communication with the GPCs from electrical engineering and computer science (CS was still part of the College of Engineering at the start of this research), only two individuals even qualified to participate from those disciplines. Additionally, this small population captured the views of participants who self-selected to be in the study, which were all white and mostly male. As such, their individual stories were highly similar and paralleled each other. This research may have limited transferability to underrepresented students in engineering doctoral programs who likely have different stories and career considerations.

Finally, faculty are an integral part of the discourse around how and what career resources engineering doctoral students access and utilize. No matter what type of career a participant planned to pursue, they primarily relied on their research advisor or other faculty for guidance. My research on mentoring between women faculty and graduate students in science and engineering has brought attention to the importance of faculty mentoring as a career support for graduate students (Gelles et al., 2018; Gelles et al., 2019). Faculty were not included as part of the discourse analysis in this study because I did not have the level of trust and rapport needed to interview faculty participants. This can be addressed in the future by having another faculty member conduct faculty interviews. The analysis has shown that Insiders such as faculty shaped how the doctoral student participants in this study viewed career resources, and future studies should include faculty and other Insiders as critical contributors to the discourse around career prospects and resources for engineering doctoral students.

CHAPTER 6

CONCLUSIONS AND IMPLICATIONS

6.1 Conclusions

The participants in this study were primarily focused on attaining academic careers, but the type of career function or vocation they were pursuing (i.e., research, teaching, service, engineering) varied. Participants described various opportunities, support, and time to pursue skill development related to technical skills associated with conducting research and communication skills associated with academic writing and publishing papers. In contrast, teaching-focused participants had to make time and opportunities for teaching skill development. Research emerged as central to engineering doctoral identity at all stages of their development and was reinforced by ‘insiders’, or people who had or were pursuing a Ph.D. in engineering. This value of research came at the cost of relatively devaluing other skills, career functions, and career resources. Depending on the career function participants wanted, they constantly had to negotiate their fit within this engineering doctoral identity and navigate the academic culture. This influenced the skills they developed and how they crafted tactics to purposely develop the skills that were not reinforced by structural requirements of their programs or assistantships. While the participants negotiated their perceived fit between their chosen vocation and their departmental and institutional cultures, their perceptions and experiences of time shifted between present demands and future career goals. Each professional development opportunity and career resource was evaluated for the relative short-term cost of time to perceived long term future benefit. The participants struggled to optimize their time, and in response utilized Time Adaptive Tactics such as flexibility, networking, and using career resources.

Context and proximity were important in offering career resources to the engineering doctoral participants. They put higher value on resources that were more specific to their identity (e.g., specific to graduate students) with perceived value increasing with specificity. The participants also attributed higher value to resources that considered their time challenges and offered multiple ways to access the research that was independent of time and location (e.g., broadcast recordings). However, the career resources that participants utilized were influenced by Insiders and how they implicitly showed they valued those resources. Resources that were brought to the engineering doctoral students by Insiders (e.g., inviting staff into classroom or seminars) were given an implicit seal of approval. Career Services, which offered similar and convenient opportunities to be invited into classrooms, was not brought into proximity with engineering doctoral students. Subsequently, while participants expressed the value of using Career Services as an undergraduate student, they did not utilize those resources as a doctoral student. The perceived cost-benefit of career resources may be influenced by the hidden norms and expectations perpetuated and reinforced by insiders.

6.2 Implications and Future Research

Implication #1: While the participants had different career resource needs and different supports, they all shared a common need of maximizing their limited present time to achieve their future career goals. In this way, time is a tangible resource that insiders such as faculty and outsiders such as university staff can provide to engineering doctoral students. This time resource must be considerate of the various roles and needs of all concerned actors. It must be flexible and allow for the intentional building of social capital (i.e., networking), and negotiated with insiders, outsiders, and engineering doctoral students.

Implication #2: We need to consider how students, faculty, departments, student services groups, and institutions define and negotiate objective and subjective time. Recruitment and retention of domestic students may increase in importance to departments if international enrollment continues to drop. By being more flexible in how and when students complete their degree requirements, institutions may be able to recruit a more diverse domestic and international student populations who have intrinsic motivation but poor timing alignment. This in turn could have implications for faculty serving at research-intensive universities, who also have to navigate objective and subjective perceptions of time and metrics of success focused on research.

Implication #3: The majority of participants in this study wanted teaching or research focused careers and could articulate the important skills necessary for those types of careers. However, some doctoral students may be attracted to other types of career functions such as wanting to help others (i.e., service). The one participant who wanted a service-focused career in academia did not articulate knowing or developing any skills that are specific to excellence in service. This may be indicative of hidden norms of how research, teaching, and service role statements are valued by academics (Neumann & LaPointe Terosky, 2007; Ward, 2010). Future research should explore what skills are important to service-focused careers and how those skills can be developed within graduate studies.

Future Research: Future research needs to explore how other aspects of alignment or fit (e.g., timing) affect the recruitment of engineering doctoral students, especially underrepresented minority students. Participants in this study were motivated by faculty who gave them the confidence and financial resources to pursue a Ph.D. at the right time. Like with career resources, recruitment may be an issue of proximity for domestic engineering doctoral students. If decisions to pursue a Ph.D. are based upon timing, funding, and meeting with faculty at the right place and right time, it is likely that faculty are integral to recruitment processes for domestic students. On the other hand, faculty may also be considering the 'fit' of future students into their research groups. This cultivation of future doctoral students could have implications on the underrepresentation of women and racial or ethnic minorities in engineering doctoral programs. While programs may have open calls on their websites for recruitment of students, if faculty are not actively and personally recruiting underrepresented students then underrepresented students may not consider applying.

6.2.1 Implications for International Engineering Doctoral Students

This dissertation focused on the needs of domestic students as a starting point of a much larger discussion about graduate education and its future challenges. Research institutions in the United States are reliant on doctoral students for vital teaching and research functions (Golde & Dore, 2001; Goldman & Massy, 2011) and many of those students are international students. International students make up 51.2% engineering doctorate recipients in the United States and have the highest stay rate (~75%) of any field (NCSES, 2018). International graduate student enrollment and applications have dropped for the second year in a row with engineering experiencing the largest drop (-

16%) in international student applications from Fall 2016 to Fall 2017 (Okahana & Zhou, 2019). With increasing competition from other countries, complicated and unfriendly immigration policies, and increasingly negative rhetoric surrounding immigration (Gluckman, 2018; Redden, 2018; Wermund, 2018), engineering programs will have to find creative solutions to recruiting and retaining both domestic and international students. While this dissertation has offered some insight on domestic engineering doctoral students, future research must consider the unique challenges and supports in international student career development needs. Unlike domestic students, international students on nonimmigrant F-1 visas do not have the same access to federal funding sources that domestic students do, and they are not allowed them to work off-campus during the course of their degree (USCIS, 2018a). After receiving their degree, international students can apply for a two-year Optional Practical training Extension for STEM Students (OPT) if an employer is willing to sponsor them (USCIS, 2018b). Recently, the current administration has tried to eliminate the OPT program and this program has been challenged in court on the basis that it denies employment opportunities to U.S. citizens (Stacey, 2019).

International engineering students may have exacerbated issues of timing misalignment as they not only have to negotiate timing between the institution, future employers, their personal lives, but also USCIS. Objective time challenges could be hindering the recruitment and future employment opportunities of international students. F-1 Visa issuance and OPT program delays by the U.S. Citizenship and Immigration Services (USCIS) can hinder the timing of recruitment, taking classes, and employment of international students in the United States (Benderly, 2019; Neelakantan, 2019). On the other hand, international doctoral students in engineering have shown more interest in academic careers than domestic students (Roach & Sauermann, 2017), so it may be likely that international students have a high Person Vocation fit and may ascribe to the academic norms of valuing research. However, international students undergo different identity development challenges than domestic students where some identities can reinforce each other and make things easier (e.g., valuing research) but some, such as cultural identity, may be at odds (Crede & Borrego, 2010). Research has shown that international doctoral students primarily rely on their research advisor for information and support (Rose, 2005) and thus they may not be accessing on-campus career resources. Access and information of career resources for international students requires an understanding of immigration issues that faculty advisors or other university staff may not have.

6.3 Final Remarks

When developing the list of career resources as part of the Action Research component of my study, I was confronted with the harsh reality that nearly all of the funding opportunities and extra professional development such as internships were only available to domestic students. International students have fewer options for skill development outside of their programs and have to navigate complicated visa and immigration issues upon graduation and finding employment in the United States. As I conducted my research, I realized how inadequate the resources I found were for the specific employment issues that international students face. While I had access to a plethora of resources and full support from my research advisor to pursue professional development in industry, government, and policy careers, I had already cleared a hurdle that I did not even have to think about. The Time Adaptive Tactics of flexibility, networking and using time and location independent career resources, remain a transferable lesson to *all* engineering doctoral students. Action research serves the dual purpose of creating meaningful change and at the same time, creating a change in the researcher. I believe that while the direct impact of this dissertation is small, these small changes can snowball into something that could change the nature of graduate education.

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APPENDICES

APPENDIX A: DATA COLLECTION PROTOCOLS

IRB Proof of Certification

Laura Gelles

From:	noreply@usu.edu
Sent:	Thursday, September 13, 2018 6:05 PM
To:	Idalis Villanueva; Laura Gelles
Subject:	Approval letter from USU IRB

Institutional Review Board

UtahState University
OFFICE OF RESEARCH AND GRADUATE STUDIES

USU Assurance: FWA#00003308

Exemption #2

Association for the Accreditation of Human Research Protection Programs, Inc. Full Accreditation

Certificate of Exemption

FROM: Melanie Domenech Rodriguez, IRB Chair

Nicole Vouvalis, IRB Administrator

To:	Idalis Villanueva, Laura Gelles
Date:	September 13, 2018
Protocol #:	9586
Title:	Career Prospects And Resources Of Engineering Doctoral Students

The Institutional Review Board has determined that the above-referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #2:

> Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (a) information obtained is recorded in such a manner that human subjects can be identified, directly or through the identifiers linked to the subjects: and (b) any disclosure of

human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

This exemption is valid for three years from the date of this correspondence, after which the study will be closed. If the research will extend beyond three years, it is your responsibility as the Principal Investigator to notify the IRB before the study's expiration date and submit a new application to continue the research. Research activities that continue beyond the expiration date without new certification of exempt status will be in violation of those federal guidelines which permit the exempt status.

As part of the IRB's quality assurance procedures, this research may be randomly selected for continuing review during the three-year period of exemption. If so, you will receive a request for completion of a Protocol Status Report during the month of the anniversary date of this certification.

In all cases, it is your responsibility to notify the IRB prior to making any changes to the study by submitting an Amendment/Modification request. This will document whether or not the study still meets the requirements for exempt status under federal regulations.

Upon receipt of this memo, you may begin your research. If you have questions, please call the IRB office at (435) 797-1821 or email to irb@usu.edu.

The IRB wishes you success with your research.

4460 Old Main Hill | Logan, UT 84322-4460| PH: (435) 797-1821 Fax: (435) 797-3769 | EMAIL:irb@usu.edu

UtahState University

Participant orientation meeting outline

- **Discussion of Purpose:**
  "My goal is to uncover and understand what career paths domestic engineering doctoral students are pursuing and what resources at USU they are using to pursue their careers. With an increasingly competitive academic job market, the job search can be a stressful and challenging aspect of doctoral candidacy. While faculty advisors are typically able to mentor their students on securing some careers, some may be unaware of how to mentor students on pursuing all types of postdoctoral careers. Through this study, I intend to better understand what careers engineering doctoral students are seeking and connect them to a greater pool of career resources at USU that are applicable to all types of intended career paths."

- **IRB Consent Form Handout and Explanation:**
  The research team will emphasize the voluntary nature of the study, and disclose exclusion and inclusion criteria, risks, and benefits.

- **Explanation of Research Design and Data Collection Protocol**
  Participants will be oriented about the nature and purpose of Action Research and Narrative Inquiry, how they will be utilized in the context of this study, and how both student, staff, and departmental perspectives will be brought together in a discourse to enact meaningful and sustainable change. Participants will have an opportunity to ask any questions about the data collection protocol, their role, confidentiality, and the larger scope of the research. The researcher will indicate that participants can choose the space that they would like the interview to be conducted in (inside or outside of campus), and whether they wish to be audio-recorded.

  To summarize the research design, participants will be walked through the following information:

  a) The purpose of Action Research and narrative inquiry and their potential role within it
  b) The overall research design (student and staff) and how both perspectives will be brought together in a discourse
  c) Expectations and levels of participation
  d) The intended action taken after data collection and preliminary analysis
  e) Data collection options, confidentiality, and privacy issues
  f) Questions, concerns, and comments
  g) Information about submitting IRB consent form (in person or by email), time limits for choosing to participate in study, and scheduling appointment information

- **Meeting dismissed**

Semi-structured interview for engineering doctoral students

Pre-Interview

- Contact participant to remind them of their interview.
- Be sure audio-recorder is working and charged.
- Print out interview note template and interview protocol.
- Arrive at interview location to set up interview space.

Interview

[*Participant enters the room*.]

[*Interviewer greets participant and engages in friendly conversation*.]

Interviewer: Do you have any questions about the study? Would you like me to explain what is happening today?

[*Interviewer briefly outlines the interview protocol in various levels of detail based on the uncertainty of the participant's response*.]

Interviewer: Thank you for participating in this study. I appreciate you helping me with this research. At any point during the interview you can decide not to answer a question. Let me know when you would like to skip a question. Also, please let me know if you need clarification on any of the questions. You can also opt not to be audio-recorded. Are you okay with this interview being recorded?

[*Participant answers. Researcher starts audio-recording contingent on response*.]

Before we begin, I would like to remind you to please consider your responses in the context of the existing University support systems.

Ice-breaker Questions:

1. What is your current academic discipline?
2. How many doctoral students are there in your department?
3. How close are you to completing all your degree requirements?
4. In a few sentences, briefly describe your research.
5. What do you think is the purpose of a Ph.D. in engineering?
6. What do you think differentiates an engineer with a Ph.D. versus a bachelor's degree?
7. What value do you think a Ph.D. gives you in terms of employment opportunities?
8. How do you think a Ph.D. is perceived in your field by all types of employers? Why?

Doctoral Student Development Questions:

1. Tell me about how you decided to pursue a Ph.D. in engineering.
    a. When?
    b. Motivations?
    c. People who influenced you? (Friends, relatives career paths)
    d. Return from industry/other?

2. Tell me about what types of jobs or careers that interested you before you became a doctoral student.
    a. Why interested?
    b. Influenced your decision to get a Ph.D.?

3. What other considerations **<u>influenced your decision</u>** to pursue a Ph.D.?
    a. Financial
    b. Family
    c. Fit

4. What did you **<u>wish you knew</u>** about your doctoral program before deciding to enroll? Why?

5. Tell me about your current **<u>career goals</u>** or aspirations.
    a. Immediate
    b. Long term
    c. Have they changed? Why?

6. Let's talk about your **<u>job search</u>** process. How is it going?
    a. Actively/passively searching? Describe.
    b. Are you confident/worried? Why?
    c. What challenges in finding a job? Why?

7. Okay, now let's talk about the **<u>skills</u>**. What types of skills have you developed as a doctoral student?
    a. Technical, teaching, problem solving, communication, leadership, teamwork, securing funding, economic/commercial, interpersonal, critical thinking
    b. Where did you learn these? (coursework, research, teaching, other?)
    c. How are these skills relevant to your field?

8. What skills do you think are most important specifically for your chosen career? Why?
    a. How have you developed these skills?
    b. Have coursework or research/teaching opportunities helped?
    c. Are there barriers? If so, what?

9. What skills have you not had enough time or opportunities to develop?

Fit Theory

10. What type of employment opportunities do you think are available with a Ph.D. in your field?
    a. Underqualified/overqualified
11. What is important for you in terms of employment quality? (e.g. work-life balance, location, independence)? Why?

12. In what situations would you take a job or employment opportunity that does not fit with these ideals?
    a. Compromises
    b. Short term positions

13. Imagine you are about to graduate. You have sent out many applications, been interviewed, and have received at least one temporary position job offer. Explain how you would make a final decision about future employment.
    a. Multiple offers
    b. Family

Career Resources:

14. Where do you typically seek information about careers or professional development?

15. Let's talk about the individuals or groups that have helped you with your career goals. How have they supported you?
    a. Family and friends?
    b. Advisor?
    c. Department?
    d. University (e.g. Career Services)?

16. What type of professional development activities on campus have you participated in?
    e. Useful?
    f. Department based? Department support?

17. What could the university do to further support your career development needs?

Interviewer: Do you have any questions for me?

[*Participant answers*]
[*Interviewer stops recording*]
Interviewer: I have stopped recording. This will conclude the interview. Remember, at any point you can decide not to participate in this study. If you have any additional questions or comments, I encourage you to contact me. Thank you!

Engineering Doctoral Skills and Competencies for Staff Participants

Instructions:

The table below is a list of skills and competencies that doctoral students in engineering need for **all** types of careers. Please take a few minutes and read through the list and underline or circle any of the skills that you think are relevant to the resources you have shared with graduate students. This can also involve personal interactions you have had with graduate students.

Type of Skill	Definition
Technical	Techniques that are required to conduct research effectively. These can include designing experiments, computational research, modeling, developing and using specific techniques or computer programs, deep knowledge in a content area, data analysis, procedure development, testing hypotheses, technical competency, mastery of engineering, science, and math fundamentals, and employing rigorous research methods.
Problem solving	The ability to define a problem, break it into parts, and customize a solution depending on the context.
Critical and analytical thinking	Objective analysis and evaluation of a situation or problem in order to form a judgment.
Teaching	The ability to impart knowledge or skill to someone. These skills include: preparing a class, developing curriculum, presenting, grading, and mentoring others.
Leadership	The ability to guide or direct a group. These skills include: project management, networking, managing people, conflict management, time management, team-building, motivating others, supervising others, administrative skills.
Communication	The ability to convey information to an audience. These skills include: written (e.g. reports, emails, memos), oral (e.g. presentations, phone), and interpersonal communication. This also includes the ability to tailor information to non-academic and non-technical audiences.
Interpersonal	The ability to interact with others harmoniously. Attributes of this skill include: possessing empathy, emotional intelligence, resilience, knowledge of social expectations and customs, and passion.
Teamwork and Collaboration	The cooperative effort of people in a group who work together. These skills include: working with others including in multi, cross, inter, and trans-disciplinary contexts and cultural competency.
Organizational Culture & Ethics	The ability to adhere to standards of personal and disciplinary behavior, values, and guiding principles. This includes adherence to institutional mission or organizational culture, knowing the field, and knowledge and adherence to professional codes of ethics, and environmental and safety regulations.
Economic and Commercial	The ability to incorporate economic and commercial factors into problem solving and decision-making. These skills include: budget-making, economic analysis, cost-benefit analysis, understanding commercial implications of research, marketing products, identifying customer needs, protecting intellectual property, and translating research findings to business applications.
Securing funding	These skills are those needed to secure funding at an organization. Examples of these include: grant writing and entrepreneurship.
Working independently	The ability to work with little guidance and think independently.

Career Resources for Staff Participants

Instructions:

Please take a few minutes to look at the list below and mark any of items on the list that you have ever **assisted, provided, or shared information** to graduate students about.

> *Note:* This can be through forwarded emails or any other way you could have helped or shared this information to graduate students.

Professional and Skill Development

- Trainings or seminars on campus (e.g., GrTS, grant-writing workshop, teaching workshop)
- Research events (e.g., Research Week, Ignite USU)
- Professional development activities
  - Conferences
  - Travel expenses for conferences
  - Internships
  - Research or teaching assistantships
  - Certificate programs
- Departmental seminars that help further develop research and career skills or that focus on networking, applying for a job, the tenure process, other careers possibilities, etc.
- Classroom guest speakers that provide professional or skill development
- Writing or research help (e.g., dissertation writing help, literature searches)
- Responsible Conduct of Research training

Support

- Scholarships or funding opportunities
- Awards (e.g., departmental, RGS/SGS, etc.)
- Professional engineering societies (e.g., ASME, ASCE, ASEE)
- Student groups on campus (e.g., professional societies, E-council)
- Connections with previous engineering graduate student alumni
- Career Counseling (e.g., Career Services)

Applying for Jobs

- Resume or CV help
- Teaching Philosophy help
- Research statement help
- Job search strategies or search engines
- Interviewing tips
- Forwarding specific job opportunities
- Career Counseling (e.g., Career Services)

Optional Interview with Staff Participants

Pre-Data Collection

- Contact participant to remind them of their interview/focus group.
- Be sure audio-recorder is working and charged.
- Print out interview/focus group note template and protocol.
- Bring food/drinks to location
- Arrive at location to set up space.

Interview/Focus Group

Interviewer: Do you have any questions about the study? Would you like me to explain what is happening today?

[*Interviewer briefly outlines the interview protocol in various levels of detail based on the uncertainty of response(s)*.]

Interviewer: Thank you for participating in this study. I appreciate you helping me with this research. At any point during the interview you can decide not to answer a question. Let me know when you would like to skip a question. Also, please let me know if you need clarification on any of the questions. You can also opt not to be audio-recorded. Are you okay with this interview being recorded?

[*Participant(s) answers. Researcher starts audio-recording contingent on response*.]

<u>Questions:</u>

1. How long have you working in your current role at Utah State University?

2. Please describe how you see your role as university staff in helping students.
    a. Undergraduates
    b. Graduate students
    c. What differences have you noticed in how undergraduates and graduate students ask for or utilize your help?
    d. What other responsibilities do you have in your role?

3. What is one thing you wish all graduate students knew about your role or the services you provide?
    a. Why?

4. When I use the term “career resources” for engineering graduate students, what are some examples you can think of? (e.g., CV help, applying for jobs, trainings)

5. Where do you think engineering graduate students typically get information about their career prospects or resources?
    a. Advisor
    b. Department
    c. Institution

Types of Career Resources:

Take a look at the handout I have provided. Please take a few minutes marking any items on the list that you have ever assisted, provided, or shared information to graduate students about.

Note: This can be through forwarded emails or any other way you could have helped or shared this information to graduate students.

6. Of this list, which have you shared or provided the most frequently to the graduate students in your department?
    a. Why?
    b. Did anything stand out?

7. Describe a situation where you shared or provided one of these resources with graduate students.
    a. What was it?
    b. Where did the information come from?
    c. Why did you provide/share it

8. Was there anything else that you may have provided or shared with engineering graduate students that was not mentioned on this list?
    a. If so, can you describe?

9. What individuals or groups do you think could best help you provide resources to graduate students?
    a. How could they help you?
    b. In your experience, what has been most effective? (e.g., classes, seminars, one-on-one)

Skill List:

I am going to provide you with a list of skills and competencies that doctoral students in engineering need for all types of careers. Please read through the list and underline or circle any of the skills that you think are relevant to the resources you have shared with graduate students. This can also involve personal interactions you have had with graduate students.

10. Of the resources you have provided or shared with graduate students, which do you think are the most valuable to graduate students considering these necessary skills?

11. You mentioned some skills that can be developed unintentionally through interactions (e.g., transdisciplinary communication and collaboration). How do you think these skills could be intentionally cultivated?

12. What do you think are the challenges in providing information or resources to graduate students?
    a. Why
    b. Value

13. How do you think your office or department can help graduate students seek out career resources and professional development despite these challenges?
    a. How would you address a graduate student's perception that they do not need your help?
    b. How could others help you address this perception?

14. How do you think other offices or departments at Utah State University can help graduate students seek out career resources and professional development despite these challenges?

Ending:

15. Are there any final comments you would like to make?

16. Do you have any questions for me?

[*Participant answers*]
[*Interviewer stops recording*]

Interviewer: I have stopped recording. This will conclude the interview/focus group. Remember, at any point you can decide not to participate in this study. If you have any additional questions or comments, I encourage you to contact me. Thank you!

Questions about GrTS (Staff Participant)

1. When did GrTS first get started at USU?

2. What was the motivation of creating GrTS?

3. Has that motivation evolved or changed since its inception?
    a. If so, how?

4. What role do you think GrTS plays in a graduate student's professional development?

5. What factors go into selecting the content of the sessions? (e.g., student feedback, availability of speakers?)

6. What feedback have you received from students about GrTS?

7. I have noticed some student surveys sent out about GrTS. Can you tell me a little about how GrTS is evaluated or assessed?
    a. Are there any other assessment measures other than student feedback?

8. What have been your most highly rated or attended sessions?
    a. Why do you think they were so well liked?

9. What types of students typically attend GrTS sessions?
    a. For example: Masters vs. Ph.D.? Certain Colleges? Newer graduate students vs. more experienced?

10. What are some of the challenges associated with GrTS?

11. In your experience, what do you think are the best ways to motivate graduate students to seek out or access the professional development resources?

Member Checking Email to Doctoral Student Participants

Hello [Participant],

I wanted to thank you again for participating in an interview for my dissertation study back in October. I ended up interviewing 9 total student participants from four engineering disciplines and I talked with 4 different staff members on campus. While I was not able to conduct all aspects of the study that I had intended (i.e., focus group), I wanted to provide you with a brief summary of results and the compiled career resources that I developed from this dissertation. If you would like to discuss the results further, I would be more than happy to talk about my dissertation with you!

If you have time, I was hoping I could ask a few more questions that you could perhaps answer over email. Answering these is completely voluntary, but in light of my results I thought I should ask a few more questions.

1. How have your short- or long-term career goals changed (or not changed) since your interview?
    i. If you defended your dissertation or graduated after your interview, can you describe where you are working now and what you are doing?

2. Has your department or major professor/research advisor ever invited university staff (e.g., library, career services) into your classrooms, seminars, or other locations/events?
    i. If so, can you describe who (e.g., career services) was invited and what they talked about?

3. How important do you think is it to be flexible in the types of careers you consider now and in the future?
    i. Why?

Thank you again for your participation.

Regards,

[Signature]

APPENDIX B: RESEARCH METHODOLOGY SUPPLEMENTS

Table B-1. Summary of data collection/generation activities.

Data Generation Activity	Population	Research Methodology	Research Stage	Description of Data
#1	Doctoral Student	Narrative Inquiry	Interviewing and Transcription	Interview transcript by IRB certified transcription service
#2	Doctoral Student	Narrative Inquiry	Interviewing and Transcription	Researcher generated interview summary memo directly following interviews
#3	Doctoral Student	Narrative Inquiry	Thematic Analysis	Researcher generated coding memos
#4	Staff	Action Research (Minimum Participation)	Staff resource identification and interviews	Career resource identification (e.g., websites, handouts, documents)
#5a	Staff	Action Research (Flexible Participation)	Staff resource identification and interviews	Interview transcript by IRB certified transcription service
#5b	Staff	Action Research (Flexible Participation)	Staff resource identification and interviews	Researcher memos generated after formal and informal data collection
#5c	Staff	Action Research (Flexible Participation)	Staff resource identification and interviews	Email interview textual responses
#6	Doctoral Student & Staff	Combined	Discourse Analysis	Researcher generated memos from discourse analysis
#7	Doctoral Student & Staff	Combined	Restorying	Researcher generated literary narrative (3 scenes)
#8	Doctoral Student & Staff	Combined	Action Taken	Researcher generated compilation of results summary and career resources
#9	Doctoral Student	Combined	Optional Member Checking	Optional member checking through email exchange (7 DS responses)

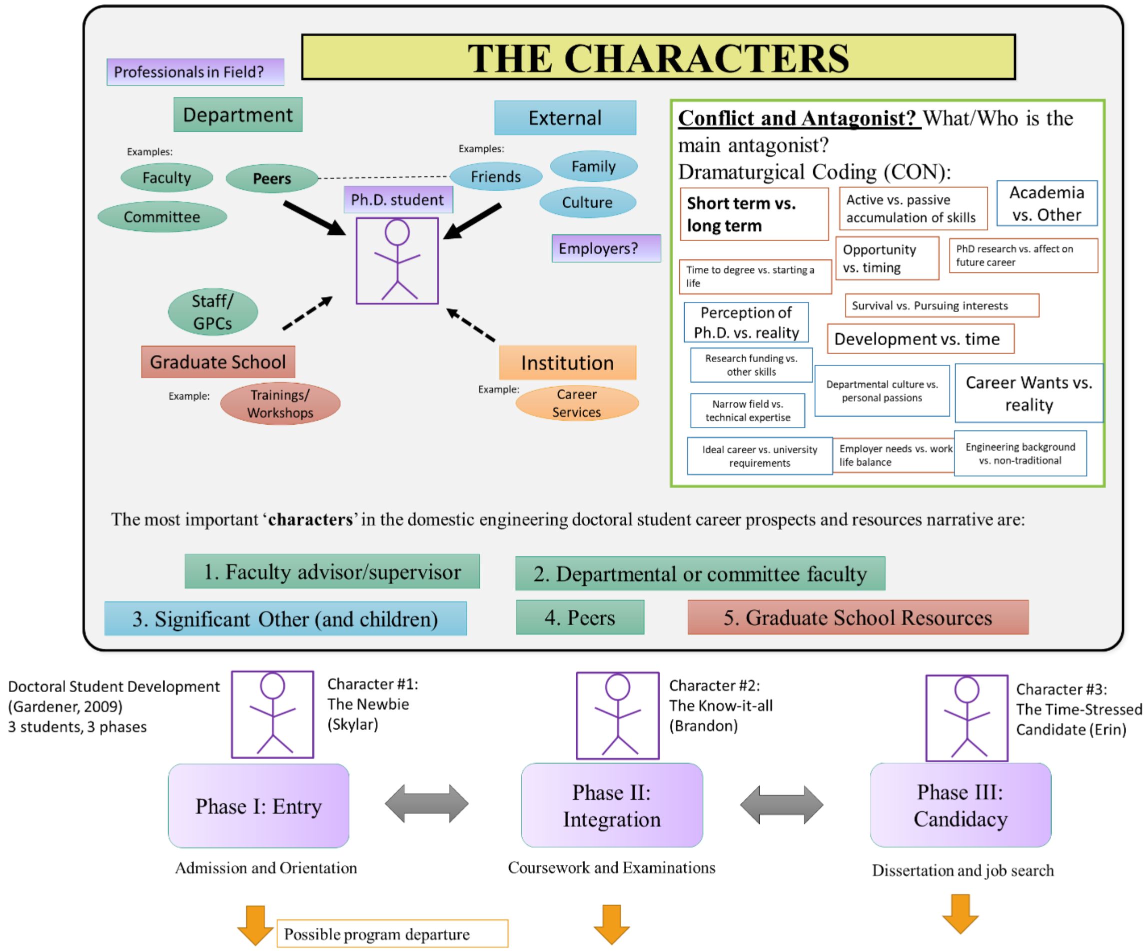

Figure B-1. Storymap of characters utilizing dramaturgical coding and the theoretical framework.

APPENDIX C: CODEBOOK AND INTERCODER AGREEMENT

Career Prospects and Resources of Domestic Engineering Doctoral Students Codebook

This codebook reflects several large categories that emerged through many iterative cycles of coding. There are two larger themes that these categories all fall under, but for this intercoder agreement you will be coding 7 categories that fall within these 2 themes.

Theme #1: Time
Categories: Present Time (Objective Time), Future Time (Subjective Time)

Theme #2: Goal Setting
Categories: Doctoral Identity (Insider, Individual Negotiation, Outsider), Development (Skill development, Tactics & Career Resources)

Coded Categories
1. Present Time (Objective Time)
2. Future Time (Subjective Time)

3. Insider Definition
4. Individual Identity Negotiation
5. Outsider Evaluation

6. Skill Development
7. Tactics & Career Resources

Accompanying Tables

1. Objective and Subjective Time
2. List of Doctoral Skills from Literature
3. Tactics and Strategies

Table C-1. Codebook category: Time.

Name of Code	**Present Time (Objective Time)**	**Future Time (Subjective Time)**
Description	See Table C-4. Present time is the objective measurement of time. It is an absolute measurement or 'clock time'. Time is considered continuous with a linear form of advancement (past to present to future). Present Time is measured in units and is experienced the same by individuals (e.g., seconds, days, months, etc.). Time is measurable and a scarce resource. It can be controlled and allocated for maximum efficiency. This form of time is identical across all individuals.	See Table C-4. Future time is a subjective understanding and experience of time. Its units are not measured the same by every individual. It is relational, meaning that it is relative to the surrounding context. This includes cultural expectations and norms of time (e.g., being early means being on time, being expected to show up much later to events, etc.). Situational influences have an effect on an individual's experience of time. This includes repetition, predictability, and emotional impact. Individuals remember the past, perceive the present, and anticipate the future. They are not simply living in the present, but constantly navigating between past memories and their future expectations.
Inclusion Criteria	This includes situations where a Ph.D. student is aware of the many tasks they have to complete by external deadlines. They want to complete their Ph.D. quickly and within the guidelines the university sets. It involves students describing time management and organization as they try to optimize and allocate their time efficiently. This includes job application timelines and how they coincide or conflict with institutional requirements. Attaining work-life balance is included because it involves efficiently allocating objective and limited measurements of time.	This includes the concept of 'timing', where individuals decide to pursue a Ph.D. because events aligned or they had support (e.g., financial, personal). This includes participants actively seeking skill development even when it conflicts with university requirements or a research advisor's expectations. This is a conflict between short term tasks vs. long term benefits and includes subjective measurements of time such as wasting time, saving time, never enough time, or time setbacks. This includes the time it takes to develop as a future professional vs. what is encouraged and allowed by universities, departments, and research advisors.
Exclusion Criteria	Issues of 'timing' in pursuing a Ph.D. or a career is not present time. Consideration of how skills and tasks contribute to their intended future career. Evaluations on how long a Ph.D. takes to complete as this are individually experienced and relative (e.g., dissertation defense scheduling is dependent on a student's independent work and their committee's relative schedules).	Survival of the Ph.D. process is not future time as it is dependent on objective time measurements and deadlines set by institutions or factors outside of the student's control. Applying to or researching jobs in the present is not future time.

Table C-1 continued.

Typical Exemplar	"Time. Job searching and filling out job applications can be time intensive especially if you're trying to finish up your dissertation or any kinda classes. So that would be a challenge, just finding the time to fill out applications and write resumes and things like that. That would be the main concern, I think."	"That's a good question because the job I'm doing right now, I don't need a Ph.D. for. That said... So, I guess I was looking for a job change before I started the Ph.D. and I kind of viewed the Ph.D. as a way to change what I was doing. The job I have right now, as I said, does not depend on the Ph.D. and I was kind of pursuing it and starting the Ph.D. around the same time. And the Ph.D. started a little before the job did. And so that has represented a change and that it wasn't necessarily dependent on the Ph.D.."
Atypical Exemplar	"If I'm getting a teaching position where I'm teaching four classes in a semester...Right now, I'm only teaching one graduate class and three undergraduate labs. And so, those take a lot of time already. If I have to teach four classes in a semester though, I don't know how I'm gonna keep my head above water. I just don't. But I assume the first time through where you have to write your notes or revise notes if you have the ability to borrow from anyone, like that's gonna take a lot of time upfront, but I'm assuming once you go through it, it'll minimal revising to at least survive the following year and every subsequent year."	"I mean obviously experience and things like kind of washes out your degree, you know, 10 years down the road. Like, how much does it matter? But who knows? Yeah. So, I guess, it wasn't necessarily a direct I do not meet these qualifications for the jobs I want. It was more of if I were to pursue a graduate degree, I would be a better candidate for them. I would be able to, you know, start off running. I just felt like I wanted to be at a better place before entering the workforce for me personally"
Close but no	"Not necessarily...like so I guess financial, short-term and long-term. Short term in the sense that I'm going to be living as a student for four more years, so that factored in kind of on the negative side. But then also thinking about I'll graduate and get a job that's going to be, you know, it's going to pay very well"	"Because they are all capable of doing the work independently, but I think that, you know, whereas me and the other doctoral students have that little bit more space. But I think that might just be because we have plenty of time to fail and then start over and continue before we graduate."

Table C-2. Codebook category: Engineering doctoral identity.

Name of Code	Insider Definition	Individual Identity Negotiation	Outsider Evaluation
Description	An insider is anyone within the context of academic research institutions who has or is seeking a Ph.D. in that respective field (i.e., engineering and/or engineering education). They set and reinforce definitions of what it means to have a Ph.D., what the Ph.D. means, what skills are necessary to have a Ph.D. They can be faculty, administration, post-docs, and doctoral seeking students.	The individual refers to the engineering doctoral student as they navigate and negotiate what is expected of them to attain and have a Ph.D. and other personal and professional needs. This code describes aspects of their socialization process and fit into academia by exposure to insiders, but they are also balancing that with the requirements of their future career and other individuals important to them.	Outsiders are people who do not have an engineering Ph.D. but have an opinion on how useful a Ph.D. is. Outsiders can be employers outside of academia or university staff who have various levels of understanding of the skills, aptitudes, and interests of people with Ph.D.s. Outsiders can also be family, friends, or anyone important to the participant who has not been socialized into the norms of academia. Outsiders are subjectively judging the value of a Ph.D.
Inclusion Criteria	Descriptions of what functions and skills are valued (e.g., research, technical) and not valued in academia (e.g., teaching), mentions of research as a critical component to a Ph.D., the prestige and elitism associated with having a Ph.D. and/or engineering. Descriptions of what a Ph.D. does that a B.S. or M.S. in engineering does not do (e.g., innovation and pushing boundaries). Descriptions of what is necessary to be successful in academia (e.g., publish or perish).	Doctoral students describing how well they fit or do not fit with the insider and outsider definition of a Ph.D. Doctoral students describing conflicts between university requirements (e.g., dissertation, research assistantship) and their ideal career. This identity negotiation is a continuous and iterative exploration of how they manage to reconcile insider and outsider perceptions of their degree. Participants describing what is important to them in a future career as it pertains to using their Ph.D.	This encompasses the participant's opinion on how others view the Ph.D. Participants relate how non-academic employers view hiring someone with a Ph.D. (e.g., expensive, inefficient) and what skills that employer values. Descriptions of what is valued from non-Ph.D. engineers including the prestige of a Ph.D. This also includes participants mentioning how university staff are unable to help Ph.D. students.

Table C-2 continued.

Exclusion Criteria	Specific skills and strategies an individual student uses to be successful or to find a position within and outside of academia. An individual's personal wants or needs conflicting with what they know is important in academia. Outsider perceptions of what a Ph.D. is.	Specific skills and strategies an individual student uses to be successful or to find a position within and outside of academia. Participants describing the differences between how outsiders view a Ph.D. and what a Ph.D. entails. Describing job fit that is more logistical than about what it means to have a Ph.D.	Specific skills and strategies an individual student uses to be successful or to find a position within and outside of academia.
Typical Exemplar	"The purpose of a Ph.D. is to introduce the student to research, to help the student learn how to do research, how to recognize good research, and to get your foot in the door basically with expanding the field, which is involved through research, essentially."	"So, I'd say that if I were to apply with the Ph.D. for the 90% of the jobs in that town, one, I wouldn't be happy with the position because I think that it would be routine-repetitive and not that exciting."	"That sometimes, an employer will say that you're overqualified and they won't hire you. But I've heard other people say that it's not as big a deal as long as you're willing to, you know, maybe not get paid as much or something like that."
Atypical Exemplar	"And I think there's more of an attempt to get things right instead of just good enough"	"I've been mostly focused on research and haven't taken a whole lot of time to work on professional development. There's not a whole lot of push for that, I would say."	"I think oftentimes Ph.D. students can be too focused, or those with Ph.D. could be too research-oriented for the field, at least in structural engineering and focus more on making things."
Close but no	"Okay, so it'd be amazing if you did that, but I don't think most Ph.D.s are trying to get a job out of their dissertation. Like, yeah, it's kind of setting you up maybe for a direction to go with your research in the future, but a lot of it is really just showing you know what to do. "	"And one of the specific boxes that I like about academia is the professor summers are a lot more flexible than a typical industry job. And I honestly can't imagine working in industry and having to be grateful that I get 10 days of vacation a year because that's nothing."	"So, I would probably need to really sell my skill set and help...and maybe, you know, try and convince them why this is something they'd want. Because the job for what I want to do probably would not be just a vacancy. You know, it wouldn't just pop up. I'd have to have them open a new position for that. So, that could be a challenge. "

Table C-3. Codebook category: Development.

Name of Code	**Skill Development**	**Tactics & Career Resources**
Description	The skills that are necessary to be a Ph.D. student and a future professional with a Ph.D. in the career of an individual's choosing. Development also entails the process of gaining and refining skills through activities and tasks required within a Ph.D. program *and* outside of a Ph.D. program.	Tactics and career resources are any specific strategies or resources that a participant employs to be successful as a Ph.D. student, to gain the skills they need for future employment, and any specific resources (e.g., websites, on-campus, people) that they utilize to make themselves an attractive candidate for employment.
Inclusion Criteria	See Table 2-1 for full list of important skills for academic and non-academic skills. Participants who develop skills are becoming an expert in their field and are becoming aware of what skills are necessary for their desired career and for academic careers.	See Table C-5 and Appendix A. for a qualifying list of tactics and resources. For example: being flexible or realistic about the types of jobs a participant will pursue. Time management and priorities is considered a tactic rather than a skill when it is utilized to 'survive' the Ph.D. process or to look for employment as a Ph.D. student. Navigating implicit expectations and organizational politics as a student is also a tactic. Career Resources encompass those utilized on campus and off campus.
Exclusion Criteria	Participants employing specific strategies to develop these skills or be successful as a Ph.D. student. Socialization processes that have more to do with what values, attitudes, and beliefs are necessary to be successful in academia. Descriptions of the importance of publishing in academia should be coded under Insider definition in Engineering Doctoral Identity.	Specific skills needed to be successful are not tactics or resources. Managing time is a skill inherent in working independently, but strategically using time management skills to achieve a desired end is a tactic. Knowledge of implicit expectations is a skill while using that knowledge to achieve an objective is a tactic. Describing the process of being socialized or skill development is not a tactic.

Table C-3 continued.

Typical Exemplar	"My writing has improved quite a bit. I feel like I can write technical documents better than before"	"But, career services in the university I think has helped more on like the tool side. Though I will say like career fairs and like info sessions and stuff like that, have helped shape the career that I want to take. And I know those are organized by the career services. So, I guess in an indirect way. Yeah, they have."
Atypical Exemplar	" I personally think a Ph.D., just in general, you know, it's a Ph.D. it's like philosophy there and that you're learning what counts as knowledge in this field, how do we obtain knowledge in this field? Like what methods are acceptable and what are the big questions that people are asking in this field right now."	"So, like if a job requires certain skills or certain things that are maybe above and beyond, I'd look at the job description and say, "Oh, if this is the type of job I want, well then maybe I should start doing those sorts of things." So, that sort of thing."
Close but no	"If a skill like that shows up in a lot of places then, yeah, I'd start actively looking for some way to gain that skill. Or some something that could show that I have that skill."	"Yeah. So, in my particular situation, I'm looking for a job in a specific location. And there are so many engineering jobs in the city. Of the jobs that are there, I would say 90% to 95% of them are suitable for someone with the bachelor's or a master's degree. And those have high turnover rates or many of them, they're also, their openings come up much more frequently. And there are maybe 5% to 10%, which are eligible for someone with the Ph.D. So yeah, I'd say, I feel like I'm overqualified for the vast majority of job opportunities that I've seen in this particular city."

Table C-4. Objective and subjective time.

Source	Objective Time	Subjective Time
Fried et al., 2007	a) Also known as ‘absolute’ time or “clock time” b) Views time as continuous (linear advancement from past to present to future) c) Is homogeneous (where individuals refer to time in units (e.g., seconds, minutes, hours, years; and each unit is the same as the other) d) It is infinitely divisible e) It is universal (meaning that there is a single interpretation of time) f) It is impartial g) Tends to be dominant in American and Western cultures, where time is future-oriented	a) Also known as ‘relativistic’ time b) Is considered cyclical c) Is uneven (not homogeneous) d) Is concrete and relational (relative to the surrounding context)
Eldor et al., 2017 (added additional characteristics to previous definition)	h) Time is a measurable and scarce resource and as such should be managed, controlled, and allocated skillfully to improve employee performance and organizational outcomes (e.g., set deadlines, plan or synchronize time) i) Is independent of an individual’s perception and this perception tends to be identical across individuals j) From an organizational perspective, time is considered an asset that is used to evaluate efficiency, effectiveness, and success	e) Includes cultural time orientation and norms f) Includes organizational time and norms g) Individual factors such as temporal depth, temporal focus (individual and polychronicity) should be considered h) Includes situational influences such as repetition, predictability, and impact i) It is considered heterogeneous (some moments pass more quickly than others) j) Implies that in the preset moment, individuals recollect the past, perceive the present, and anticipate the future

Table C-5. Tactics derived from thematic analysis.

Tactic	Description
Using Career Resources	Utilizing any on campus or off campus resources (e.g., trainings, seminars, websites, advice, people) that directly or indirectly contribute to skill development, searching for, or attaining employment.
Flexibility	Being open to different types of careers or employment opportunities that do not meet an individual's ideal career or life. This can include taking temporary positions or looking at unexpected careers (e.g., FBI special agent). This includes alternative pathways to a certain career objective and making compromises and taking opportunities as they come
Networking	Networking is utilizing and leveraging an individual's current network of professionals (e.g., major professor, alumni) to attain a future career or temporary position. This includes using academics, professionals, and student and professional organizations. Networking can be done formally (e.g., conferences) or informally (e.g., advisor).
Actively seeking skill development	An individual goes beyond the requirements and activities required by their program, faculty advisor, or the institution to seek out opportunities on or off campus that could make them a better employment candidate. They may not be entirely aware of how this skill development might benefit them, but they are making an investment of time. For example, an individual could volunteer for teaching experience that interferes with their research assistantship. This includes experiential skill development (i.e., skills that are attained through experiences and not seminars/informational sessions).
Marketing self	An individual is aware of what transferable skills they have and is able to communicate those skills to a respective employer who is unaware of Ph.D. aptitudes.
Actively seeking knowledge about jobs	An individual is actively looking at the types of careers available in their field and researching what it takes to attain those jobs. This includes searching job descriptions, informational interviews, interviewing, searching websites, researching company/university culture.
Pursuing Ph.D. to qualify for desired employment	An individual intentionally seeks out a Ph.D. in order to be able to work in their chosen field (e.g., tenure-track academia).
Confidence	An individual actively displays confidence when seeking out employment and within their doctoral programs. This individual often has to show that they are capable of finishing all their explicit and implicit requirements of them as a student and employee of their research supervisor while also seeking out skills or resources that do not immediately benefit them.
Self-funding	Individuals who self-fund their doctoral education (e.g., through grants, GRFP, PDRF) are less constrained in what they research and what opportunities they can take. They can research in areas more aligned with the career they want, take internships, and are not as restricted through external time requirements (e.g., research supervisor's schedule). On the other hand, they may be more disconnected from the social capitol of their department.
Actively applying to jobs	Individuals actively apply to jobs throughout their doctoral student experience. While most students wait until candidacy to seriously consider a job search, some begin the job search from the beginning. This can pose the challenge of wanting to drop out of a program if they are offered a position that does not require a Ph.D.
Navigating departmental politics/culture	This is an ability to understand and work-through implicit requirements, expectations, or power dynamics imposed on them by their institutional, departmental, and individual lab cultures.
Survival	Focusing exclusively on the tasks that are most pressing (e.g., deadlines, research supervisor mandates) instead of seeking out skill development. This strategy is often needed for an overburdened student to simply continue pursuing their Ph.D.

Table C-6. Important job fit characteristics for engineering doctoral students.

Job Fit Characteristic	Definition	Subcategories
Type of Work	Type of Work is the actual job description, requirements, traits, assignments, and tasks associated with a job position that are required on a daily and long-term basis. These can be listed in job announcements and can be adjusted over time. Type of Work is a reflection of an individual's desired career function (e.g., research, teaching, service, engineering). Enjoyment, passion or finding meaning in specific tasks or outcomes associated with Type of Work is indicative of a good fit.	Job function, variety of job duties, predictability, creativity, intellectually challenging
Location	Location is the actual physical location that a job is positioned at that is conducive to an individual's lifestyle. Location preferences can be geographical (e.g., Western United States), preference for rural or city location, climate, culture, or proximity to family, friends, activities, infrastructure (e.g., schools), or physical landmarks that are conducive to a sense of satisfaction or enjoyment. Location can affect other job fit characteristics such as Commute & Logistics, Work-life Balance, and Financial Considerations.	City, rural, museums, nightlife, outdoor recreation, etc.
Work-life Balance	Work-life balance is the allocation of time between working time and personal time in a way that the individual perceives positively or balanced in a way that results in a healthy, enjoyable life. Work-life balance can have considerations of time spent with family (e.g., children), or time away from work to pursue hobbies and interests. Work-life balance time allocations are unique to each individual and are determined by a fixed number of hours in a day. An individual's ideal allocation of time spent on work or non-work activities is self-determined. Work-life Balance can be influenced by Work Culture and allowances of Flexibility and Independence.	Family considerations
Work Culture	Work culture is the character or personality of an organization that retains and perpetuates values, traditions, beliefs and desired behaviors and attitudes. This includes atmosphere, formality, how interpersonal competition is cultivated or discouraged, how employees are managed, workplace practices, policies, ways in which an individual is promoted or retained, and the people within that workplace. Workplace culture can be explicitly stated through policies or implicitly enforced through unstated expectations. Workplace culture can affect recruitment, selection, rewards and recognition, training and development, promotion, wellness, how individuals communicate, and work-life balance. Work Culture can be the most difficult Job Fit characteristic for an individual to assess before being hired.	Job tranquility, family friendly, team oriented, competition, fast pace, congenial atmosphere, friendships, risk taking

Table C-6 continued.

Financial Considerations	Financial Considerations are those that include how an individual is compensated for their work. This can include salary, retirement, insurance, earning potential, and benefits (e.g., health care). Financial considerations take into account a return on investment for spending years pursuing a Ph.D. (e.g., expecting a higher salary than M.S. or B.S. engineers). Financial considerations also takes into account the type of lifestyle an individual wants to pursue or how they support their current and future family	Earning potential, benefits available, job security
Helping Others	Helping others is the intentional act of directly helping individuals or contributing to the betterment of the world on small and large scales. Individuals who wish to help others seek opportunities within and outside their employment. Helping others contributes to an individual's feeling like they are making a difference. Helping others can be enacted through research, advocacy, advising, mentoring, teaching, volunteering, providing resources, and various other ways. In academia, helping others is associated with the Service part of a role statement.	Mentoring, advocacy, service
Flexibility	Flexibility is having choice over the hours or days that an individual works. Job flexibility allows for an individual to have more control over objective time allocation. Flexibility could include allowances to set a schedule or to work from home through technological means (e.g., telecommuting).	Flexible schedule
Job Prestige	Job Prestige is being recognized and appreciated for the quality of an individual's work and being acknowledged as an expert in a field. Acknowledgement can be in the form of job title, managerial duties, salary, trust, or being well regarded and respected by others inside and outside of a discipline. Having a Ph.D. is associated with a level of prestige and trust in intellectual ability and skills. An individual who valued Job Prestige would seek out positions where their degree was acknowledged and valued.	Expert status
Independence	Independence is working with little guidance, direction, and oversight. Individuals who value Independence like to set their own schedules, tasks, and measurable accomplishments. Independence naturally pairs with Flexibility and is an aspect of Workplace Culture.	Work alone, supervision
Commute & Logistics	Commute and Logistics are any aspect of a job that reflect the daily realities of working. Commute is a measure of time that must be added into the calculation of Work-life balance and can be influenced by Location. Other logistical aspects can include specific policies (e.g., sick leave, holidays) and required travel (e.g., conferences).	Traffic, travel
Promotion & Career Trajectory	Promotion and Career Trajectory is the way in which an individual advances in their organization. Depending on the organization, some paths to promotion are clearly laid out while others are left to interpretation or implicit understanding. Career Trajectory can mean advancement to higher ranks or to a more desirable position. For example, a short-term postdoctoral research associate position can be used to develop the skills and publications necessary for a more desirable job (i.e., tenure track faculty). Career Trajectory allows for skill development, networking, and other professional development.	Professional development, learn new things

Intercoder Agreement Rules

1) Read each segment of text found in the excel cell

2) Assign a code from at least 1 of the 3 groups

   - Time Group= Present and Future Time
   - Identity Group= Insider Definition, Individual Identity Negotiation, Outsider Evaluation
   - Skills and Tactics Group= Skill Development and Tactics & Career Resources

3) Multiple codes can apply to each segment, but only one from each group

4) If codes from multiple groups are coded, highlight the one you think is most important

   - Example: Future Time, Individual Identity Negotiation

5) If no code fits for the ice-breaker questions, do not apply a code

   - Example: "I'm not sure exactly. I would guess probably 10."

6) For 'I don't know' or 'no' responses, do not apply a code

   - Example: "No, not really."

7) For clarification responses, do not apply a code

   - Example: "Can you repeat the question? Sorry."

8) Inter Coder Agreement percentage will be calculated from agreement of the highlighted code if multiple categories are coded.

Intercoder Agreement Example

<table>
<tr><td colspan="7">Interviewer: Okay. Thank you. All right. So, what is important to you in terms of employment quality?</td></tr>
<tr><td colspan="7">DS #9: What is important to me?</td></tr>
<tr><td colspan="7">Interviewer: So, for example, work-life balance, location, independence.</td></tr>
<tr><td colspan="7">DS #9: I think all three of those are important. The work-life balance is important to me. I would like to not work a million hours a week and be able to spend time at home with family. So that would be important. Location is a bit important but I'm pretty flexible there as far as where I need to go. That would probably be the least important, maybe.</td></tr>
<tr><th>C#1: Time</th><th>C#1: Identity:</th><th>C#1: Skills & Tactics</th><th>C#2: Time</th><th>C#2: Identity:</th><th>C#2: Skills & Tactics</th><th>Agreement</th></tr>
<tr><td>Future</td><td>Individual</td><td>None</td><td>Future</td><td>Individual</td><td>None</td><td>Yes</td></tr>
</table>

APPENDIX D: CONSTRUCTED NARRATIVE

Narrative Explanation

A narrative was created after synthesizing doctoral student stories using the context derived from discourse analysis. The narrative is intended to provide a more accessible and compelling story that exemplifies the findings of this dissertation and brings the three themes together in a more concise format. This narrative is broken into three separate scenes that follow the progress of a doctoral candidate as she prepares for her dissertation defense and searches for a job. Interwoven into the narrative are the themes and categories of this analysis and events that were inspired by the doctoral student participants in this study. The characters in this narrative are an amalgamation and exaggeration of the stories related by the engineering doctoral participants. While elements may be similar to doctoral student participants, they do not represent one participant's unique story. The characters, a description of the scenes, and the relevant themes and categories are provided in Table D-1 and D-2 below.

Table D-1. List of characters.

Character	Description
Erin	A Ph.D. candidate in engineering who is progressing towards defending her dissertation and is worried about her job search. Erin struggles to manage her time and focuses on getting her dissertation research completed. At the same time, she is aware that she needs to be doing more to find a job before she graduates.
Brandon	A second-year doctoral student in Erin's department who has a good understanding of how things work in engineering academia.
Skylar	A first semester doctoral student who wants a teaching-focused career. Skylar is eager to learn from his fellow students, especially about getting a career in academia.
Dr. Russell	Erin's major professor and head of her dissertation committee. Erin conducts research for Dr. Russell under a research assistantship.
Jennifer	Erin's friend from her undergraduate education where they took engineering classes together. Jennifer went into industry for a few years right after her bachelor's degree and then went back to school for her master's degree.

Table D-2. Summary of the narrative scenes, characters, and relevant themes and categories.

Scene	Characters	Description	Major Themes	Relevant Themes and Categories
#1: There's Always Time for Research	Erin, Brandon, Skylar, Dr. Russell	Erin, a doctoral candidate, is giving a presentation on the research she has been conducting with Dr. Russell in the graduate student research seminar. The other graduate students interact before the seminar and Skylar, a first semester doctoral student, is eager to learn about research and finding a job from his peers. Brandon, a second-year student, remarks that Erin should be applying for jobs now because of how competitive the academic job market is. After Erin's presentation, Skylar tries to get more information on finding an academic position from her. She tries to explain part of the tenure process and role statements to Skylar who is primarily interested in teaching.	Engineering Doctoral Identity & Objective Time	Research as Central to Identity, Teaching as Secondary Function, Negotiation of Fit, Survival, Time Management and Priorities, Salient Engineering Doctoral Skills
#2: Outsiders Don't Know	Erin, Jennifer, Brandon	Erin is having lunch with her friend Jennifer, a master's student, from her undergraduate engineering classes. After hearing how frustrated Erin is with searching for a job, Jennifer tries to convince Erin to go to the STEM career fair put on by Career Services. Erin insists that they cannot help doctoral students, but Jennifer convinces her to be flexible and go anyways. Just as Erin begins to agree to go with her friend, Brandon shows up and tells Erin that Dr. Russell is looking for her.	Engineering Doctoral Identity & Time Adaptive Tactics	Outsider Evaluation, Negotiation of Fit, Optimization and Efficiency, Work-life balance
#3: You Don't Have a Job Yet?	Erin, Brandon, Skylar	After successfully passing her dissertation defense, Erin is anxious that she does not have an employment commitment yet. Brandon and Skylar congratulate her and ask about her job prospects. After telling them about her lack of offers, Brandon comments that it might be because she needs more publications and that she should ask her major professor for help. Erin is considering a position which requires teaching experience, which she does not have. Skylar is excited about the position and thinks she should apply. Brandon does not think she should bother. Erin decides to use her professor to help her find jobs, but also to be flexible and apply to the teaching-focused position anyway.	Subjective Time & Engineering Skill Development	Timing, Short Term vs. Long Term, Time Adaptive Tactics, Present Job Search, Restricted Skill Development, Career Function Skill Alignment

Scene #1: There's Always Time for Research

Skylar looked excitedly as students, faculty, and even some faces he didn't recognize filtered into the graduate student research seminar. He looked down at his notebook and carefully wrote the date and the title of the seminar, which was displayed on the screen for the entire department to see. One of the more experienced students was presenting some of the research they were working on with their major professor. He smirked as he scrawled at the long title that took up at least two lines in his handwriting. Erin, a more experienced student, was up at the front, speaking quietly with her major professor. Skylar watched as she nodded a few times and generally looked tired. It was a hardened expression he saw on the older students as they made it through the gauntlet that was getting a Ph.D.

Erin went back to the computer where their research presentation was uploaded to. She sighed softly before rapidly scrolling through the slideshow and stopping. She quickly changed some of the text before flitting back to the title slide. She offered a small, somewhat encouraging smile to her fellow students as more and more people filtered in.

Brandon set his bag down next to Skylar, offering a polite greeting before looking around the room to see who was there. Many were already seated, sipping their refreshments or talking animatedly with their colleagues about an upcoming conference, a grant proposal, or some award they had just won.

"Hey Erin! Long time, no see." Brandon greeted cheerfully, his eyes looking up to the projection screen. Erin moved closer to where Brandon and Skylar were seated. "Oh, it's your turn this week? Nice!"

"We all gotta do it," Erin responded casually, "just wait until it's your turn."

Brandon laughed. "I suppose that'll happen when I know what I'm doing?"

"No one knows what they're doing. We're all just really good at faking it." Erin shook her head with well-practiced, self-deprecating humor.

Brandon laughed along with the ritual of it. It was all part of the Ph.D. experience.

“Is this your dissertation work?” Brandon wondered, his eyes tracking the overly long and technical title that left little room for an interesting visual.

Erin shook her head sharply, her lips thinning into a forced smile. She looked towards the back of the room where the department had set up a table of sustenance—coffee, tea, cookies. Offering sugar and caffeine was a great way to make sure people stayed awake, including herself.

“No, this is the research I’m doing for my assistantship. It’s similarly related.”

“Ah, that makes sense.” Brandon nodded, accepting this as absolute reality. “So, when are you going to defend?”

Erin shook her head then shrugged. “Not sure, yet. I’m still analyzing the data, then I have to write it all up, and schedule the committee but their schedules are so hard to match up, and one of my committee members clearly doesn’t like my methodology, and…”

Skylar blinked as the more experienced student listed off several tasks he only vaguely knew of. Just listening to it made him feel anxious. Did he have to start doing that yet? He was still taking classes, but it seemed like all the other students were working on research and presenting at conferences.

“What about jobs? Are you applying yet?” Brandon asked, knowing that was what they were asking the other Ph.D. candidates. “Isn’t it like super competitive?”

Erin nodded, looking anxiously back towards her presentation, which was supposed to start in a few minutes. Her major professor looked at his watch, likewise aware of the time.

“Did you hear about the Civil engineering department?” Brandon asked, eyes alight with that special glow of insider knowledge.

Skylar blinked in confusion as Erin nodded grimly.

“I mean…should we even try if it’s going to be that competitive?” She remarked with exhaustion. “They expect us to tailor these cover letters, research statements, and teaching philosophies to each position but I only have so many hours in the day! Oh, and I'm not even done with my dissertation or know if I'm going to pass my defense."

"Wait, what? What about Civil engineering?" Skylar interrupted the two more-experienced students.

Brandon drummed his fingers on the table as Erin once again looked at the clock.

"They recently opened up a tenure-track assistant professor position in the department. I heard they received over a hundred applications." Brandon explained as Erin went back to the front of the room to prepare. "They narrowed it down to four and they're bringing them all to campus."

"Oh, that's crazy!" Skylar smiled. "How do they decide?"

Brandon shrugged. "Probably publications?"

"Like who has the most?" Skylar asked eagerly, carefully filing this information away. He wanted to be an engineering professor.

"Yeah, and how prestigious the journal."

"Prestigious? What does that mean?"

Brandon did not answer as the seminar began to start. Skylar tried to concentrate on the highly technical presentation as Erin carefully described the methodology, but he was soon lost in the extraordinary amount of detail. His mind began to wander at what Brandon had said about how competitive it was to get a position in academia. Maybe it would be better when he was looking for jobs. He knew publishing was important, but how many publications should a graduated engineering Ph.D. recipient have? How long did it take to get published? How did you publish? His mind wandered so much he practically missed the results, his eyes glazing over the tables of numbers and p-values. Erin summarized her findings nicely and Skylar looked around the room to see most everyone nodding, their hands to their chin as their eyes focused on the screen. Even the other students were nodding as if they understood everything Erin had said. Skylar looked down at the scribbled notes he tried to take, unable to write down anything as eloquent as Erin's summarized findings. He decided to nod anyway.

He expected Erin to look relieved that her presentation was over, but her eyes steeled for battle as she put on the next slide.

Any questions?

Many of the professors raised their hand and began to grill the candidate with questions. She constantly flipped back and forth between her methodology slides and her results slides, clearly stressed as she tried to answer each and every one with gravitas in the face of their unrelenting intense barrage of critique. She was doing well, but it was not over. A full professor squinted at the presentation and then asked a question she had not anticipated. She floundered for a bit, reiterating her methodology for a few agonizing seconds that felt like years before finally admitting the truth.

“Well, I don’t think we thought of that particular factor when designing the study…” She looked to her major professor for a life raft or some saving grace.

Finally, after another few silent and time-defying seconds, Dr. Russell spoke shortly and succinctly to his fellow professor. They nodded in understanding. The answer had appeased the other, trusting in his background and credentials. The bombardment of questions eased after that. Finally, all questions were addressed, and Erin was thanked.

“Don’t forget about our next seminar in two weeks!” The department head reminded the gathering as they started packing up. “We’re having our librarian come in to give the students some tips on literature searches, citation metrics, and spotting predatory journals!”

With that, the students and professors packed up their things, chatting amiably but still in a rush to get to their next dire task. Erin closed out of her presentation, removed her flash-drive, and spoke briefly with Dr. Russell.

“So…I have to do that?” Skylar asked before Brandon could leave.

“At least once.” Brandon confirmed.

“Is it just research?”

“Usually.”

Brandon was clearly anxious to leave as everyone else. He clutched his phone, looking at the emails that had piled up. He quickly scrolled through the list, seeing several that were not important. One from student affairs about some sort of social event—delete! Some emails from his engineering professional society about an upcoming conference—ignore for now! One from Career Services about the upcoming career fair—delete! That was just for undergraduates anyway. One from his major professor—look at and answer immediately!

"Sorry, gotta go!" Brandon smiled good-naturedly at the first-year student, holding up his phone as evidence before quickly ducking out of the room and heading back to the graduate student office of cubicles.

Skylar looked around at the rest of the students he barely knew as they filtered out. Seeing Erin was still there, packing up her things, he quickly latched to her side.

"So, that's normal?" He asked. "Presenting and then getting grilled by professors?"

She smirked. "Yeah, pretty normal."

"So…you're applying to academic positions?" He quickly changed the subject to what had really captured his attention.

He followed her out of the room and presumably back to where Brandon had been headed. Maybe he could catch up with him there.

"When I have time. I don't know…" Her shoulders tensed and she looked off to the side. "I check the job boards. You know, Inside Higher Ed, AcademicKeys, LinkedIn."

"LinkedIn?" The younger student blinked in confusion.

Erin shrugged, not wanting to explain at the moment that she was not exclusively looking at academic jobs. As they entered the graduate student office, Skylar did not peel off to his own desk but instead followed the doctoral candidate. He raised his eyebrows at the relative chaos that surrounded her computer. Textbooks were open and bookmarked, lying on top of each other amidst a panoply of highlighters, haphazardly strewn pens, and printed journal articles. She sat exhaustedly in her chair and moved her mouse. She entered her password and revealed an equally overloaded desktop with internet browser tabs, email, word documents, pdfs, modeling programs, and her calendar. She made a face at the calendar before turning towards Skylar who was looking curiously at all of this disarray.

“So, what type of faculty position are you looking for?” Skylar asked curiously.

“Um…tenure-track, I guess?”

“Cool! Me too! I can’t wait to be a professor. I have so many ideas about what type of classes I want to teach and how I will do it. I mean lecture is *okay*, and necessary sometimes with big classes…but I think when I teach, I can really make it engaging, you know?”

Skylar was practically vibrating and dancing on his toes with the passion he had for his imagined future role as an engineering professor. Erin paused, her eyebrows furrowing.

“You know…you have to do a lot of research too, right?” She asked cautiously—not wanting to take the wind out of her peer’s sails.

“Oh…well *yeah*.” He seemed to wave off her unspoken concern. “But isn’t that what’s cool about being a professor? Your schedule is really flexible and as long as you get your work done…I mean you have your classes and you get your research done outside of classes.”

He trailed off as he saw the look on her face. She was not smiling like before.

“Right…” She was not sure if she could correct him. He seemed to have all the confidence he needed. She thought for a bit and then decided to rephrase what she was not being clear about. “But you know about, like, tenure? The process?”

“I know it’s brutal!” Skylar smirked at her and she could not help but smirk back. That was certainly true.

“Yeah, definitely.” She laughed a bit. Well, he seemed to know what he was doing. Still, she felt like she had to say one more thing. “But as part of that process, you have your role statement.”

“Role-statement?” It sounded familiar to Skylar, but he was not quite sure about it.

“When you’re going for tenure, you have to prove you’re capable in specific ways. You know, show excellence, be recognized for your contributions to the field. So, you have this role-statement and it’s broken up into three categories usually: Research, Teaching, and Service.”

“Oh, cool! So, you prove you’re great in those three areas and then you get tenure.”

She nodded. “And you negotiate this role statement when you get hired. Think of it like percentages: 60% research, 30% teaching, 10% service.”

This time Skylar crossed his arms a bit. “But you said negotiation, right? Like if I wanted to spend 60% of my time on teaching…”

“Well it’s not…exactly time-based. That’s not what that means.” She struggled to explain. “You’re not spending that percentage of your time towards that.”

Skylar shook his head in confusion. This was just like her presentation—like he was missing some foundational knowledge that everyone else knew.

“Okay,” she pivoted, “think of it like an assignment rubric where you’re graded on three questions. So, you see that you can get 60 out of 100 points on one homework question, and like 10 out of 100 on another. You only have a limited amount of time to complete your homework and turn it in. Each question is super complicated and can take up all of your time if you let it. What do you do?”

“Well I…”

Skylar was an engineer; he knew all about optimizing his time with tough assignments to get the best grade possible. But still, it didn’t make sense. He needed to talk to someone else. He looked in the direction of Brandon's cubicle. He shifted his weight back and forth from each foot. Erin's eyes were drawn back to her calendar and then to the time displayed at the corner of her screen. Preparing for the seminar presentation had already taken up so much time, and she needed to catch up.

Her dissertation wasn't going to write itself! Oh, but she had to finish that conference paper first. Then look for jobs. And sleep sometime.

"I have to get back to my work. I hope that helped?"

He nodded half-heartedly and they exchanged a pleasant goodbye. She wanted to explain more, but she really had to get back to work.

Scene #2: Outsiders Don't Know

"Okay, but if you're that worried about getting a job then why don't you go to Career Services or something. Isn't that *their* job?"

Erin sighed in frustration. Her friend just did not get it! Jennifer was a master's student that she met when they were both in the same undergraduate engineering program. They had struggled and fought to pass every difficult and time-consuming engineering class while balancing their other required classes and trying to have a semblance of a social life. While Jennifer went into industry for a few years, she returned to get a master's degree to increase her earning prospects. Despite their shared undergraduate engineering experience and Jennifer also doing some research as a master's student, Erin was convinced she just could not understand what it was like to be a doctoral student and what that entailed.

Still, it was nice to take a break from her modeling, analysis, and writing to have lunch with her friend. The well-meaning question about future employment had touched a sore spot that her friend immediately dug into. Erin looked down at the remnants of her food, drumming her fingers on the table. It seemed like everyone she knew was asking her the same question. What was she going to do after the Ph.D.? Where was she going to work? When was she going to graduate? She could barely even think about that when she had so much to do *right now*.

Her friend did not back down, expecting an answer to their seemingly logical question. Erin sighed again.

"Look, maybe Career Services is great for getting like…a job right out of your bachelor's degree, but what do they know about Ph.D. jobs? Besides, I don't have the time for that."

"It's literally a ten-minute walk across campus." Jennifer rolled her eyes good-naturedly. "All I know is that they helped me with my resume, and job search and even interviewing practice! They have a STEM career fair coming up—didn't you see the email? You should totally go."

"Right." Erin shook her head with a bit of sarcastic snort. She didn't even have a resume that wasn't egregiously outdated. Everything was on her CV, and industry employers did not want to look at a CV. "Because the engineering companies there are *totally* looking for Ph.D.s. They're not just looking for interns or undergrads about to graduate."

"Well, why not? I'm getting my master's degree and *I'm* going. I bet your degree gives you a huge advantage. I mean, how many people at that fair are getting their Ph.D.? You'll stand out!"

Erin rolled her eyes. "They're not looking for Ph.D.s. I mean, c'mon they're engineers too, right? They probably think it would be inefficient to hire me. I'm overqualified. They would think I'm too expensive. They all think we take years to solve a single problem when they're looking for a quick 'good enough' answer." She ticked off these excuses one by one.

"What, did you ask each and every one of them?" Her friend challenged.

"No..." She responded defensively, crossing her arms.

"Do you *want* to work in industry?" Jennifer did not plan to be a career counselor today, but Erin was being stubborn.

"Well…*maybe*. If I get to do research…and I got a little bit of independence, like no manager breathing down my neck. And…well like some semblance of work-life balance. I mean, this Ph.D. thing is a nightmare already. I'm barely surviving… and then it just gets worse as a faculty, right?"

Jennifer nodded. Her major professor was a tenure-seeking assistant professor, so she had seen first-hand how much time and energy it took.

"So…I mean industry sounds good in that respect, but I just don't know if I'd get to do what *I* wanted to do. Because I love research. I really love it, so academia seems like the right path but…I don't know. Maybe a government research institution, but I don't even know where or how to apply for those. Where do they advertise jobs? Whatever…I'll figure it out."

When she had some time, she would finally figure all of this out.

"You'd be a great professor; you'd be a great engineer. You'd be a great whatever you want!" Her friend was insufferably positive about all of this. It was both annoying and endearing. "But you gotta be *flexible*. Keep your options open. Isn't that what got you to go for a Ph.D. anyway?"

Erin rested her hand on her chin, thinking back across the eons of her doctoral experience.

"If I remember correctly, you said you had absolutely no intention of getting a Ph.D. when we were getting our bachelor's degrees. *You* said that it was way too much time and not enough money."

She nodded, smiling at the reminder and how different she felt now. She could not imagine herself doing anything but research.

"Then your major professor encouraged you to do it, and now you're here…almost done! You never know what you'll be good at or what you like until you do it. So why not keep your options open? What if you went into industry and then went into academia? What if you went into academia and changed your mind? What's stopping you?"

"I guess…" What Jennifer said was starting to make a lot of sense.

“So…come to the career fair with me? We could do that whole networking thing. I hear that’s important.” Jennifer continued to needle.

“My dissertation—“

“—Can wait! This is your future we’re talking about.”

Erin mumbled an uncertain agreement but felt slightly confident about it. What if there were employers who were looking for Ph.D.s? Maybe she could at least find out what they were looking for.

The two friends were about to wrap up lunch and go back to their respective labs when Erin caught sight of Brandon. He smiled and waved, approaching the two with confidence. He did not bother with small talk.

“Oh, hi Erin. Dr. Russell was looking for you. You should probably get back.”

Erin looked at the time on her phone and sighed. Talking with Jennifer had been helpful, but there never seemed to be enough time in the day.

“Hey, are you going to the STEM career fair?” Jennifer tried to use Brandon as one last reinforcement against her friend’s intransigence. If her peer thought it was a good idea, then she would have no choice but to go.

Brandon laughed like she had made a joke.

“You’re kidding, right? That’s for undergrads! I don’t want to waste my time.”

Scene #3: You Don’t Have a Job Yet?

“Hey! I heard you passed. Congratulations! Should I call you Dr. Erin now?” Brandon beamed a smile at Erin, stopping by her office cubicle as he walked through the door.

She looked up blearily from the teaching statement she was trying to revise and the CV that seemed far too short. She had done more than this, right? It felt like she had done more.

“Not yet… “She brought up the document that held her dissertation and all of the revisions she had to make.

He looked closer, nodding as he saw a snippet of the comments and the tracked changes. “That seems about right.” He offered. “But wow, I bet you’re so relieved right?”

“You have no idea!” She smiled genuinely, feeling briefly free of one weight.

The defense had been nerve-wracking, and her committee had raked her over the coals on the methodological details and the conclusions she had drawn from the data. Despite this gauntlet of fire, they all agreed that (as long as she made the extensive corrections) she passed. Still, as she thought about it her smile began to falter. There was that *other* thing to consider now. Now that one weight had been lifted, she had to pick up the other one—the much heavier and important burden. The great culmination that her degree was supposed to lead to. The thing her friends, family, peers, and other faculty had not stopped asking about since she passed her defense.

“So, do you have any job offers?” Brandon asked that same question she absolutely hated right now.

She shrugged a bit, trying to avoid the growing panic that was setting in. This part seemed almost worse than the defense. “I got a few interviews.” She remarked. “Haven’t heard back.”

“Oh…that’s good you had interviews! But you know you really need to get on top of that. You should have a job offer lined up when you graduate.” He remarked sincerely.

She nodded in acknowledgement. Yeah, that was obvious *now*. And if she was being honest with herself, it had always been obvious…always at the edge of her consciousness. Now that the defense was done, it had become the most immediate task and she felt woefully unprepared.

“I wish I would have been a little faster.”

“Hmm?”

“With the dissertation. There was interview a few months ago. It went *really* well. They really liked me, and I think it was a good fit. But they wanted me to start right away. I didn’t even think I’d get it in the first place. It was kinda perfect for me. I mean, I probably could have worked harder and finished my dissertation earlier. I could have…but…”

The timing was just off.

“Where’d you interview? Did you get any invites to campus?” He continued to question. “Did you try for postdocs too? That’s what I’m going to do, you know as a backup.”

“Oh, you know…there was an assistant professor position in Nebraska, I tried for some in California…then Florida. You know, all over.” She remarked. “Anywhere, really.”

“It’s competitive.” He said knowingly, sighing. “Even I’m a little worried.”

Before she could respond, Skylar got up from his desk and approached the two more experienced graduate students.

“Oh hey, Skylar. Did you hear, Erin passed her defense? That means she’s just like all the other faculty with Ph.D.s. She’s finally on the ‘inside’.”

“Congratulations! That’s awesome!” Skylar’s excitement was infectious.

He was right. It was awesome! She did not know how it was so easy to forget that.

“We were talking about jobs.” Brandon explained. “You need to be looking like a year before you plan to graduate and you really gotta time it right with faculty jobs.”

Skylar nodded eagerly.

“Erin was saying she applied to some faculty positions, but no luck so far.” He summarized.

"I…even applied for some industry positions." She added, trying to make her situation sound better, or maybe she was trying to prove that she had done everything she possibly could.

"Industry? That's an option?" Skylar asked. "They hire Ph.D.s?"

"Yeah, of course." Brandon waved this off like it was common knowledge. "You know I applied to industry too. Just for fun, at the start of my program." He said good-naturedly. "I'd look at job announcements and see if any interested me. It's really good practice. So, do you think you'll go into industry?"

She scoffed. "At this point, I think I'll go any place that takes me."

"Yeah, just getting your foot in the door is important. That's why I was thinking of postdocs. I could really get more publications."

She thought of her own meager CV and her single first-author journal publication, the five conference papers, and three posters she had under her name. It *seemed* like a lot for four years, but maybe it wasn't. Maybe everyone else had published in more prestigious journals.

"I just wish it didn't take so long to publish." She growled in frustration.

She had a feeling that the faculty positions she applied to had discounted her because of her lack of publications. She had written several, but only one had been published so far. The others were stuck in revision limbo.

"Paper revisions are *ridiculous*." Brandon commiserated. "But that's the whole point, right? Peer reviewed science is what sets us above everyone else. We're the ones solving the world's toughest problems. We come up with innovative concepts and ideas and we get it *right*. Not just good enough, but *right*. And peer review ensures that its right and everything checks out. If you can get past the peer review process that's like…well that just says that other experts say you are right."

"I *guess*," she grumbled. "I still think it takes way too long."

"Absolutely." He agreed wholeheartedly.

Skylar seemed to be soaking everything that was said like a sponge, but he seemed uncomfortable. Erin knew that feeling well. That was the feeling she had when she first realized how difficult getting a Ph.D. would really be.

“Where else are you applying to?” Brandon continued his line of questioning.

She brought up a job announcement on her computer and he skimmed through it. He then winced and clicked his tongue. Skylar looked at it, smiling and nodding at the job requirements. That sounded perfect!

“This one looks like they’re looking for someone to teach a bunch of classes and maybe some research on the side.” Brandon summarized.

She looked uncertainly back on the job posting she had spent hours working on already.

“They’re probably going to ask you to prove your teaching skills. I mean, it’s always a plus if you have the publications *and* the teaching. Still…”

“I don’t…I haven’t taught.” She said hopelessly. “I went to a grad school seminar, but that’s it…I have a research assistantship, not a teaching one.”

Was she supposed to be working on her teaching skills too? Was that something she missed?

“Is there a way to teach?” Skylar wondered. He was on a research assistantship like most everyone else, but if he could be a TA or get some practice teaching some undergraduate classes, that would suit him better.

“Maybe you should talk to Dr. Russell about this. This is probably not even worth your time. You want to do research, right?” Brandon ignored Skylar’s question.

Erin looked back at the announcement. It was not the perfect job, but she really liked the university’s mission statement and the location. It was close to her family. It looked like she would get to be mostly autonomous. That sounded pretty good.

“Right…” She said. She preferred research, but maybe she would be good at teaching too. She didn’t even know if she would like teaching. She never got the chance to find out.

“Maybe you should ask Dr. Russell if he knows of any colleagues who are looking for any postdocs or know of any positions open.” Brandon suggested. “I bet you just need more publications.”

She nodded, biting her lip.

“Well, good luck! I bet you’ll find something.” Brandon concluded cheerfully and went back to his own desk.

“I still think it sounds pretty cool.” Skylar remarked, looking at the job description on her screen. “You should go for it.”

She nodded with a smile. Maybe she should be more flexible like Jennifer said. Skylar shuffled back to his own desk, and she pulled open her calendar again—carefully planning and allocating all of her time as she usually did. She would have to schedule some time to talk to Dr. Russell. He had already agreed to write her a letter of recommendation, but maybe Brandon was right. Maybe he knew someone who knew someone. Maybe even her committee members could help.

Maybe she would even try Career Services. Anything could help at this point, right?

APPENDIX E: COMPLIATION OF CAREER RESOURCES

Summary of Results Sent to Participants

Career prospects:

- The majority (8 out of 9) of student participants were considering academic careers with **four out of nine** having a definite preference for academia.
- Only two participants were only considering one type of career.
- While participants were **flexible** in the types of careers they were considering, they clearly knew what **career function** they were interested in. These functions mostly followed the academic role statements of (1) research; (2) teaching; and (3) service. However, one participant was more interested in practical applications of research which was classified as (4) engineering.

Insiders and Outsiders:

- Research was central to Engineering doctoral identity with the student participants predominantly (8 out of 9) describing the purpose of a Ph.D. in engineering as related to **research.**
- This focus on research often came at the expense of teaching and student participants interested in teaching career functions had to individually seek out and make time for teaching professional development opportunities within their program.
- There was a demarcation between 'Insiders' (i.e., people with or pursuing a Ph.D. in their field) and 'Outsiders' (i.e., people without a Ph.D.) and that influenced what career resources the participants utilized.

Table 1. Participant listed sources of career advice or support in order of importance.

Order of Importance	Source of Career Advice or Support	Classification
1	**Primary research advisor**	**Insider**
2	**Faculty**	**Insider**
3	**School of Graduate Studies**	**Insider/Outsider**
4	**Peers**	**Insider**
5	**Professional Societies**	**Insider/Outsider**
6	**Career Services**	**Outsider**

Skill Development:

- Depending on the career function (e.g., teaching) participants were interested in, they sought out opportunities to develop the skills that were necessary for that career function. Participants interested in research and teaching functions were aware of specific skills important for those functions. On the other hand, participants did not list any skills specific to service.

Teaching focused	Research focused	Service focused
<--------------------------------Communication--------------------------		->
<--------------------------------Technical------------------------------		->
<---------------Working independently	----------->	
teaching	critical and analytical thinking	
interpersonal	securing funding	
	problem solving	

Caption: Participant perceptions of the skills that are important to their chosen careers.

- Participants described a variety of versatile skills like communication and time management that could apply to all types of careers.
- While opportunities to develop research skills were built into program requirements (e.g., dissertation), teaching skills were not. Participants seeking to develop teaching skills were not overtly hindered, but they were not actively supported by their departments.

Time:

- The participants were constantly caught between a present (i.e., objective) perception of time where they tried to optimize their schedules and allocate their limited time in the most efficient way possible and future (i.e., subjective) perception of time where they considered their future careers. This resulted in a conflict between short term requirements and long-term considerations that required Time Adaptive Tactics to resolve.
- The three main Time Adaptive Tactics were (1) **Flexibility**; (2) Networking; and (3) Using Career Resources. **Flexibility** was the most frequently utilized tactic by participants and involved being flexible in the types of postdoctoral careers they would consider and in job fit characteristics (e.g., type of job, location, work-life balance) they would compromise on.

Discourse Analysis of Career Resources on Campus:

- The participants were more likely to value and seek out career advice and help from 'Insiders' such as faculty over Career Services.
- The Graduate Training Series (GrTS) was also highly regarded because it offered content more contextually relevant to graduate students and brought in 'Insiders' to speak at their sessions. Additionally, it offered multiple ways to access these sessions in location and time (i.e., broadcast, recording).
- Participants mentioned using and valuing Career Services as an undergraduate or even M.S. student, but not using it as a doctoral student. Career Services were confident they could and had experience helping doctoral students with individual coaching. Career Services was also invited to present at a GrTS session and those sessions are usually the most highly attended.
- Library resources emerged as a relevant source of skill development for doctoral students by offering help with **research**. Most importantly, library staff were invited into classrooms and departmental seminars by 'Insiders'.

Table E-1. Skills important for academic and non-academic postdoctoral engineering careers.

Type of Skill	Code	Definition
Technical	TECH	Techniques that are required to conduct research effectively. These can include designing experiments, computational research, modeling, developing and using specific techniques or computer programs, deep knowledge in a content area, data analysis, procedure development, testing hypotheses, technical competency, mastery of engineering, science, and math fundamentals, and employing rigorous research methods.
Problem solving	PROB	The ability to define a problem, break it into parts, and customize a solution depending on the context.
Critical and analytical thinking	THINK	Objective analysis and evaluation of a situation or problem in order to form a judgment.
Teaching	TEACH	The ability to impart knowledge or skill to someone. These skills include: preparing a class, developing curriculum, presenting, grading, and training others.
Leadership	LEAD	The ability to guide or direct a group. These skills include: project management, networking, managing people, conflict management, time management, team-building, motivating others, supervising others, and administrative skills.
Communication	COMM	The ability to convey information to an audience. These skills include: written (e.g. reports, emails, memos), oral (e.g. presentations, phone), and interpersonal communication. This also includes the ability to tailor information to non-academic and non-technical audiences.
Interpersonal	INTERP	The ability to interact with others harmoniously. Attributes of this skill include: possessing empathy, emotional intelligence, resilience, knowledge of social expectations and customs, and passion.
Teamwork and Collaboration	TEAM	The cooperative effort of people in a group who work together. These skills include: working with others including in multi, cross-, inter-, and trans-disciplinary contexts and cultural competency.
Organizational Culture & Ethics	ORG	The ability to adhere to standards of personal and disciplinary behavior, values, and guiding principles. This includes adherence to institutional mission or organizational culture, knowing the field, and knowledge and adherence to professional codes of ethics, and environmental and safety regulations.
Economic and Commercial	ECON	The ability to incorporate economic and commercial factors into problem solving and decision-making. These skills include: budget-making, economic analysis, cost-benefit analysis, understanding commercial implications of research, marketing products, identifying customer needs, protecting intellectual property, and translating research findings to business applications.
Securing funding	FUND	These skills are those needed to secure funding at an organization. Examples of these include: grant writing and entrepreneurship.
Working independently	IND	The ability to work with little guidance and think independently.

*Note***.** The skills in this table were derived from an exhaustive literature search.

Table E-2. Tactics engineering doctoral students can utilize for professional development and job acquisition.

Tactic	Code	Definition
Using Career Resources	RESOURCE	Utilizing any on campus or off campus resources (e.g., trainings, seminars, websites, advice, people) that directly or indirectly contribute to skill development, searching for, or attaining employment.
Flexibility	FLEX	Being open to different types of careers or employment opportunities that do not meet an individual's ideal career or life. This can include taking temporary positions or looking at unexpected careers (e.g., FBI special agent). This includes alternative pathways to a certain career objective and making compromises and taking opportunities as they come, even if they are not ideal.
Networking	NETWORK	Networking is utilizing and leveraging an individual's current network of professionals (e.g., major professor, alumni) to attain a future career or temporary position. This includes using academics, professionals, and student and professional organizations. Networking can be done formally (e.g., conferences) or informally (e.g., advisor contacts one of their peers).
Actively seeking skill development	SKILL	An individual goes beyond the requirements and activities required by their program, faculty advisor, or the institution to seek out opportunities on or off campus that could make them a better candidate for employment. They may not be entirely aware of how this skill development might benefit them, but they are making an investment of time. For example, an individual could volunteer for teaching experience that interferes with their research assistantship. This includes experiential skill development (i.e., skills that are attained through experiences and not seminars/informational sessions).
Marketing self	MARKET	An individual is aware of what transferable skills they have and is able to communicate those skills to a respective employer, especially if they do not know what receiving a Ph.D. entails.
Actively seeking knowledge about jobs	INFO	An individual is actively looking at the types of careers available in their field and researching what it takes to attain those jobs. This includes searching job descriptions, informational interviews, interviewing, searching websites, researching company/university culture.

Pursuing Ph.D. to qualify for preferred employment	PHD	An individual intentionally seeks out a Ph.D. in order to be able to work in their chosen field (e.g., tenure-track academia).
Showing Confidence	CONF	An individual actively displays confidence when seeking out employment and within their doctoral programs. This individual often has to show that they are capable of finishing all their explicit and implicit requirements of them as a student and employee of their research supervisor while also seeking out skills or resources that do not immediately benefit them.
Self-funding	SELF FUND	Individuals who self-fund their doctoral education (e.g., through grants, GRFP, PDRF) are less constrained in what they research and what opportunities they can take. They can research in areas more aligned with the career they want, take internships, and are not as restricted through external time requirements (e.g., research supervisor's schedule). On the other hand, they may be more disconnected from the social capital of their department.
Actively applying to jobs	APPLY	Individuals actively apply to jobs throughout their doctoral student experience. While most students wait until candidacy to seriously consider a job search, some begin the job search from the beginning. This can pose the challenge of wanting to drop out of a program if they are offered a position that does not require a Ph.D.
Navigating departmental politics/culture	CULTURE	This is an ability to understand and work through implicit requirements, expectations, or power dynamics inherent in their institutional, departmental, and individual lab cultures.
Survival	SURVIVE	This strategy is often needed for an overburdened student to simply continue pursuing their Ph.D. They are only able to complete certain tasks that are the most pressing (e.g., deadlines, research supervisor mandates) and cannot seek out any other career resources or develop other skills.

Note. These tactics in this table were derived from emergent coding of engineering doctoral student participants.

Table E-3. Sources of professional development and resources on and off campus.

Opportunity	Example of Possible Support	Associated Skill(s)	Associated Tactic(s)
Trainings or seminars on campus	Graduate Training Series (GrTS), grant writing workshop, CIDI Workshops, Teaching Assistant Training (USU 7920)	[Various], TEACH, TECH COMM, LEAD, FUND	RESOURCE, SKILL, FLEX
On campus research events or conferences	Research Week, Ignite USU, Inclusive Excellence Symposium, Empowering Teaching Excellence Conference, Engineers Week	TECH, COMM	NETWORK, MARKET, SKILL, RESOURCE
Professional Society Conferences (national and regional)	AGU, ASEE, ASCE, FIE, SWE, AERA, etc.	TECH, COMM, FUND, ORG	NETWORK, MARKET, RESOURCE
Travel expenses for conferences	Research advisor grants, departmental grants, SGS travel grant	FUND, ECON, COMM	SELF FUND, CULTURE
Internships	NSF INTERN grant, industry connections	[Various] TECH, COMM, TEAM, INTERP	SKILL, NETWORK, FLEX, MARKET, RESOURCE
Research assistantships	Research advisor, other departmental faculty	[Various] TECH, COMM, THINK, PROB, TEAM, IND	SURVIVE, CULTURE
Teaching assistantship	Research advisor, other departmental faculty	TEACH, COMM, INTERP	SKILL, CULTURE, FLEX
Graduate Instructor	Research advisor, department faculty	TEACH	SKILL, CULTURE
Certificate programs	NEPA Certificate Program (Environmental), NREE Certificate (Natural Resources and Environmental Education)	[Various] TEACH, TEAM	SKILL, MARKET, RESOURCE
Departmental seminars	Research, seeking academic employment, tenure process, bringing in guest speakers (e.g. librarians), bringing alumni to speak	[Various] TECH, COMM	SURVIVE, RESOURCE
Classroom guest speakers that provide professional or skill development	Career Services, Librarian	[Various] TECH, COMM	SURVIVE, RESOURCE
Writing or research help	Thesis/Dissertation information session, Librarian	TECH, COMM	RESOURCE, SKILL, FLEX

Table E-3 continued.

Research ethics training	Responsible Conduct of Research (RCR), USU 6900: Human Research, Social & Behavioral Research Modules (CITI), Environmental Health and Safety (EHS)	ORG	SURVIVE, CULTURE
Degree required activities	Classes, dissertation	[Various] TECH, COMM, IND, PROB, THINK	SURVIVE, CULTURE
Elective classes	EED 7460: Finance & Grant writing, EED 7050: Learning & Assessment in Engineering, TEAL 6150: Foundations of Curriculum	[Various] FUND, TEACH, TECH	SKILL, CULTURE
Orientations	Graduate student orientation	ORG	RESOURCE, CULTURE
Scholarships or funding opportunities	SGS Travel funding, fellowships, Graduate Research and Creative Opportunities grant, USUSA Graduate Enhancement Awards, College of Engineering Ph.D. Student Travel Grants, SGS Dissertation Fellowship, Seely-Hinckley Scholarship, Presidential Doctoral Research Fellowship	[Various] FUND, COMM, ORG	SELF FUND, CULTURE, CONF
Awards	Departmental awards, College awards, Robins Awards, Professional Society Awards	ORG	CULTURE, CONF
Professional engineering or research societies	ASME, ASCE, ASEE, AIAA, AIA, AAAS, SWE, AGU, SHPE, NSBE, AERA, PCI, PCA, IEEE, AiCHE, BMES	TECH, COMM, INTERP, ORG	NETWORK, MARKET
Student groups on campus	Student professional society sections, E-Council, Graduate Student Council	COMM, INTERP, TEAM	NETWORK
Alumni	Engineering doctorate recipients, LinkedIn	COMM, INTERP	NETWORK
Degree progress and paperwork	Graduate Program Coordinator (GPC)	COMM, ORG, INTERP	CULTURE, SURVIVE

Note. This table acts as a general guide to help the student become aware that career resources may exist.

Table E-4. Resources specific to applying to jobs.

Opportunity	**Example of Possible Support**	**Associated Skill(s)**	**Associated Tactic(s)**
Resume or CV guidance	Career Services, GrTS, NIH, research advisor, department faculty	COMM, ORG	RESOURCE, CULTURE
Teaching Philosophy guidance	Research advisor, department faculty	COMM, ORG	RESOURCE, CULTURE
Research statement guidance	Research advisor, department faculty	COMM, ORG	RESOURCE, CULTURE
Job search strategies or search engines	Career Services, Inside Higher Ed, Academic Keys, LinkedIn, Professional societies, AggieHandshake	COMM	APPLY
Interviewing help	Career Services, GrTS, research advisor, department faculty	COMM, ORG	RESOURCE, APPLY, SKILL
Specific job opportunities	Research advisor, department faculty	COMM	RESOURCE, FLEX, PHD
Career Counseling	Career Services, AAAS Individual Development Plan, Research advisor, department faculty	COMM, ORG	RESOURCE, SKILL

Note. This table acts as a general guide to help the student become aware that career resources may exist.

Table E-5. Career resources at Utah State University.

Name	Associated Skills and/or Tactics	Approximate Date	Location	Description
Career Services	RESOURCE, INFO, MARKET, APPLY	[Various]	USU Logan Campus and Online	Repository of career guidance for students, employers, faculty which includes CV and interviewing help and information about Career Fairs, and a job search board for USU students and alumni.
Career Services Assessment Reports	INFO	[Various]	Online	Report on where graduate students found jobs including salary information broken down by B.S., M.S., and Ph.D.
Career Services Canvas Course	RESOURCE, INFO, MARKET, APPLY	[Various]	Online	Online Canvas course that orients students to the resources that Career Services offers.
Center for Innovation Design and Instruction (CIDI) Workshops	TEACH	[Various]	Online	Variety of workshops throughout the year that assist in course design, Canvas, and other integration of technology into classroom (e.g., Panopto)
CITI Social and Behavioral Research Modules	ORG	[Various]	Online	The CITI program offers training and certifications on various research topics including conducting research with human participants.
EED 7050: Learning and Assessment in Engineering	TEACH	Fall semester	USU Logan Campus	A class that offers an overview of the various methods used to measure and evaluate student achievement in engineering. The principles of learning and assessment as it is applied to Engineering Education are also reviewed.
EED 7460: Finance & Grantwriting	FUND, COMM	Fall semester	USU Logan Campus	A graduate level class offered through the department of Engineering Education. This class covers how to navigate the grant writing process with a focus on securing NSF funding for STEM educational research.

Table E-5 continued.

E-Learning Workshop	TEACH	May	USU Logan Campus	Offered by Empowering Teaching Excellence (ETE) and sponsored by CIDI and AIS. A three-day event to provide a deep dive into teaching tools and methodologies for online, broadcast, blended, and flipped instruction.
Empowering Teaching Excellence (ETE) Conference	TEACH	August	USU Logan Campus	A conference that allows individuals to interact and share insights with instructors about teaching practices.
Engineers Week	COMM	February	USU Logan Campus	An annual event with a week of engineering activities hosted by the College of Engineering. Community Night offers a way for engineers to interact with the public and explain complicated technical principles for a lay audience.
Environmental Health and Safety (EHS) training	ORG	[Various]	USU Logan Campus	Offers lab safety initial and refresher training, biosafety training, radiation training, blood borne pathogen training, and others which are required to work in some labs.
ETE Seminar Series	TEACH	[Various]	Online and USU Logan Campus	A seminar series about teaching that can be accessed in person or by webcast. Topics pertain to various aspects of effective teaching with a focus on practical application learned through experience by seasoned teachers.
Graduate Student Orientation	ORG	August	USU Logan Campus	An orientation that provides information for new students about USU, Logan, and resources on campus.
GrTS (Graduate Training Series)	[Various]	Fall & Spring Semesters	USU Logan Campus	Short workshops offered by RGS that provide valuable opportunities that promote individual capacity development, interdisciplinary integration and student engagement
Ignite USU	TECH, COMM	April	USU Logan Campus	A student speaking event during Research Week where graduate and undergraduate students can share their stories behind their research in fast-paced dynamic talks.

Table E-5 continued.

Inclusive Excellence Symposium	COMM	October	USU Logan Campus	A gathering organized by Aggies Think, Care, Act which promotes diversity and social responsibility on campus. Attendees receive education and training for understanding the experiences of underrepresented groups in order to reduce barriers to their academic and career success. The symposium also promotes networking, collaboration, and dialogue among faculty, staff, students, and community members.
Lib guide for Career Guidance	RESOURCE, INFO, MARKET, APPLY	[Various]	Online	Career Resources compiled by USU librarians including resume and cover letter tips, interview guidance, and job-hunting websites.
Lib Guides for Engineering Research	TECH, RESOURCE	[Various]	Online	Provides research help for engineering researchers on searching for literature, organizing and citing literature, and data management services.
Librarian	TECH, COMM, RESOURCE	[Various]	USU Logan Campus	Personally meet with a librarian to help with literature searches and other research help.
National Environmental Policy Act (NEPA) Certificate Program	TEAM, TECH	[Various]	[Various] Online	An Environmental specific certificate program about NEPA. The NEPA Certificate Program was designed to prepare natural resource and environmental professionals to meet the challenges of complying with the act and working effectively on NEPA documents.
Natural Resources and Environmental Education Certificate	TEACH	[Various]	USU Campus	Provides a foundation in techniques and principles in environmental education and natural resource interpretation. It offers in-depth communication skills and best practices for environmental education and outreach.
Research Week	TECH, COMM	April	USU Logan Campus	Annual week devoted to student research and awards which includes a Student Research Symposium that showcases student research.

Table E-5 continued.

Responsible Conduct of Research (RCR) training / USU 6900	ORG	[Various]	Online	Training that fulfills NIH, NSF, USDA-NIFA regulatory requirements for student and postdoctoral researchers. This provides information on the ethical conduct of research.
RGS graduate student grantwriting seminar	FUND, COMM	September	Eccles Conference Center, USU Logan campus	A modification of the faculty grant writing seminar and is tailored to the needs of graduate students and those who have little to no grant writing experience. Attendees will leave the seminar understanding the why as well as the how of grant writing.
Teaching Assistant Training (USU 7920)	TEACH	Online	N/A	A teaching assistant workshop required for all graduate students who have been awarded a teaching assistantship. A 0-credit Pass/Fail class.
TEAL 6150: Foundations of Curriculum	TEACH	Fall and Spring	USU Logan Campus and Online	A class that offers examination of theories, principles, and foundations of curriculum, emphasizing program planning and current curriculum trends.
Thesis/Dissertation Information Session	COMM	[Various]	USU Logan Campus and Online	Sessions that provide a thorough survey of USU thesis/dissertation format requirements and guidelines.

Note. Updated July 2019.

Table E-6. Sources of Utah State University funding.

Name	Associated Skills and/or Tactics	Approximate Date	Location	Description
College of Engineering Ph.D. Student Travel	COMM, FUND, MARKET, ORG, SELF FUND	[Various]	Online	Travel grant ($300) that helps cover the cost for Engineering Ph.D. students to present at an academic conference. Awarded once every two years on a first come first serve basis.
Graduate Research and Creative Opportunities (GRCO) grant	COMM, FUND, SELF FUND, MARKET	June	Online	Graduate Research and Creative Opportunity (GRCO) grants provide a $1,000 grant to support original research, scholarship, or creative work by USU graduate students with the guidance of a faculty member. Proposals include requests for funds to cover the costs of equipment, supplies and project-related travel.
Other Scholarships	SELF FUND	[Various]	Online	List of USU scholarships that apply to graduate students.
Presidential Doctoral Research Fellowship (PDRF)	SELF FUND, ORG, NETWORK, RESOURCE, CULTURE	October	USU Main Campus	A fellowship that offers unparalleled support and access to resources at USU. It is a four-year fellowship with a yearly $10,000 stipend, full tuition award, and one on one support from the Office of Research. Must be a continuing undergraduate with a GPA 3.5 or higher with a GRE score in 70th percentile and be in contact with SGS upon application into graduate school. This requires faculty and departmental support.
SGS Dissertation Fellowship	SELF FUND	April	Online	Fellowships of $5,000 for the academic year with a tuition award for in-state and nonresident students for up to 6 credits used to relieve students from their teaching and research obligations so they can actively write their dissertation.
SGS Travel Funding	SELF FUND	[Various]	Online	This travel award promotes student involvement in their disciplines by partially funding travel costs associated with presentations at conferences. It will cover $200 for regional, $300 for national, and $400 for international conferences. The recipient must be presenting and will only be funded once per year.
USUSA Graduate Enhancement Awards	SELF FUND	March	Online	The USUSA Graduate Enhancement Award is an award meant to support the outstanding graduate students at USU who have consistently shown a track record of excellence. It awards $4,000 to a full-time graduate student.

Table E-7. External career resources.

Name	Associated Skills and/or Tactics	Approximate Date	Location	Description
ALWE/SWE	LEAD, SELF FUND	July	Online/ Conference	Academic Leadership for Women in Engineering (ALWE) is a program to help foster academic leadership for women in engineering. Recipients receive travel funding to attend SWE national conference.
ERN Webinar on Non-Traditional Careers in STEM	INFO	October	Broadcast and Online	Webinar for students seeking non-traditional careers in STEM to enhance awareness of career opportunities outside of academia provided by the Emerging Researchers National Conference in STEM (NSF and AAAS)
LEVERAGE	RESOURCE	[Various]	Online	A group that creates full circles of support for diverse engineering students pursuing academic career pathways.
my IDP (Individual Development Plan)	INFO	[Various]	Online	An online resource that helps an individual examine what their skills, interests, and values in the context of a career, gives suggestions on different scientific career paths, and offers a tool to help set goals.
NIH Office of Intramural Training and Education	RESOURCE	[Various]	Online	Provides career resources for scientists including investigating career options, identifying possible employers, postdoc opportunities, CV and resume review, and skill development.
Salary data for faculty and university jobs	INFO	[Various]	Online	A database that provides salary data for faculty, staff, and adjunct staff positions at thousands of colleges.
So what are you going to do with that?	INFO	[Various]	N/A	A book with advice for Ph.D. students and graduates who want to pursue a career outside of academia. Includes chapters on figuring out what career you want to pursue, practical tips like turning a CV into a Resume, how to interview, etc.
The dissertation success curriculum	RESOURCE	[Various]	Online	Provides the skills, strategies, and support that advanced graduate students need to overcome the three biggest obstacles to finishing their dissertation: perfectionism, procrastination, and isolation
The K. Patricia Cross Future Leaders Award	LEAD, MARKET	October	Online	An award that recognizes graduate students who show exemplary promise as future leaders of higher education; who demonstrate a commitment to developing academic and civic responsibility in themselves and others; and whose work reflects a strong emphasis on teaching and learning.

Table E-8. External sources of funding.

Organization	Type of opportunity	Population	Most applicable discipline	Approx. deadline	Description
AAAS	2-year postdoctoral fellowship for those interested in science policy	Ph.D. recipients in Science and Engineering or M.S. degree in Engineering with 2 years of experience	[Various]	November	Opportunity to learn first-hand about policy making by advising the executive, legislative, or judicial branch about science or scientific issues.
AERA	$25,000 stipend for dissertation	U.S. citizens enrolled in a doctoral program	EED	September	Dissertation grant for educational research involving quantitative methods on large scale data sets to advance fundamental knowledge of relevance to STEM policy.
Zonta International Foundation	$10,000 fellowship	Women pursuing doctoral degree in aerospace-related field (U.S. and International)	MAE	November	Fellowship granted to doctoral student women in aerospace fields.
AAUW	$6,000- $30,000 fellowship for dissertation, postdoctoral research, or short-term research publication grants	U.S. citizen women in doctoral programs or post doctorates	[Various]	November	Women pursuing full-time study to complete dissertations, conducting postdoctoral research full time, or preparing research for publication for eight consecutive weeks
NASEM	12-week fellowship with $9,250 stipend	Graduate and professional school students who have completed degree in last five years in social/behavioral sciences, health and medicine, physical or biological sciences, engineering, etc.	[Various]	September	Provides early career individuals with the opportunity to spend 12 weeks at the Academies in Washington, D.C. learning about science and technology policy and the role that scientists and engineers play in advising the nation
NOAA Office for Coastal Management	2-year fellowship to match postgraduates with coastal zone programs	U.S. citizen who will complete masters or doctoral degree in environmental related studies	ENVE	October	Provides on-the-job education and training opportunities in coastal resource management and policy for postgraduate students and to provide project assistance to state coastal zone management program

Table E-8 continued.

NSF	Funding for first year graduate students in CS and Engineering	First year grad students in CS and Engineering	[Various]	October	GRFP provides three years of financial support within a five-year fellowship period -- $34,000 annual stipend and $12,000 cost-of-education allowance to the graduate institution. That support is for graduate study that leads to a research-based master's or doctoral degree in a STEM field
NSF	Internship opportunity at U.S. national organization	NSF GRFP fellows	[Various]	May & December	Expands opportunities for GRFP fellows to enhance professional development by working with governmental partner agencies to provide internships. This is a supplemental grant to the GRFP.
NSF	3-6-month internship at non-academic organization (industry, government, policy)	U.S. Citizen graduate students at least one year into program whose advisors have an active NSF grant they could supplement	[Various]	May	Provides up to $50,000 or percentage of advisor's NSF grant to get non-academic internship experience for students interested in non-academic careers.
AAUW	$18,000-$30,000 fellowship (1 year)	International graduate students or post doctorate women	[Various]	November	Funds full-time study or research within the United States
NOAA National Estuarine Research Reserves	2-year fellowship opportunity for coastal management research with $40,000 stipend per year	U.S. citizens enrolled in a graduate program with at least 2 years left in program	ENVE	December	Graduate students will be placed at the national estuarine research reserves to address key coastal management questions to help scientists and communities understand coastal challenges. The fellows' projects may influence future policy and management strategies.
National Academies	Education research dissertation fellowship ($27,500)	U.S. and International doctoral candidates within the U.S. (any discipline)	EED	October	Highly competitive dissertation fellowship program that funds research relevant to education.
NASA Office of STEM Engagement	Training grant to STEM graduate students	U.S. citizens with a bachelor's degree in STEM and enrolled in a research based graduate program	MAE	May	Program designed to support OSE objectives and provide academic institutions the ability to enhance graduate-level learning and development. Research to provide authentic STEM engagement related to NASA missions.

Table E-8 continued.

NASA	Various Research opportunities	[Various]	MAE	[Various]	List of current proposal opportunities for NASA
NOAA National centers for Environmental Prediction	Paid summer internship ($5,000)	U.S. citizen undergraduate or graduate student in relevant STEM and social science fields	ENVE, CS	February	10-week paid summer internships to work in areas that work in areas that will meet the future needs of the ever-broadening user community and address the strategic climate-water-weather issues
NASEM	Short term paid position based upon available participating agencies	Scientists and engineers at all stages of career with a doctorate. Open to U.S. and foreign citizens depending on opportunity.	[Various]	[Various]	Competitive awards for scientists and engineers to conduct independent research in federal labs and affiliated institutions. Includes stipends, health insurance, professional travel, and relocation.
Office of Personnel Management	640 work hours of experience in internship with a federal agency.	Current student at accredited school. U.S. citizen status depends on the agency.	[Various]	[Various]	Provide students enrolled in a wide variety of educational institutions, from high school to graduate level, with opportunities to work in agencies and explore Federal careers while still in school and while getting paid for the work performed. Opportunities posted on USA jobs.
Office of Personnel Management	1-year developmental program within a federal government agency	Recent graduates who have completed a degree within the last two years. U.S. citizen status depends on the agency.	[Various]	[Various]	Affords developmental experiences in the Federal Government intended to promote possible careers in the civil service to individuals who have recently graduated from qualifying educational institutions or programs. Opportunities posted on USA jobs.
Office of Personnel Management	Receive full salary and benefits will working at a federal agency.	Individuals who have graduated with a M.S. or advanced degree within past 2 years. Eligible to work under U.S. laws.	[Various]	August	Leadership development program at the entry level for advanced degree candidates

Table E-8 continued.

AAUW	$10,000 - $35,000 award	Women scholars with doctorate degree conducting basic research in engineering, medicine, or physical or biological sciences	[Various]	December	Helps women overcome gender bias barriers by providing them with funding for research projects that will culminate in scholarly publications.
DOE Workforce Development for Teachers and Scientists	Provides supplemental funds to conduct their doctoral research at a DOE lab/facility for 3-12 consecutive months.	U.S. citizen, 18 years old, full-time Ph.D. candidates	[Various]	May	Prepares graduate students for STEM careers relevant to the DOE Office of Science mission. This allows for the student to work on their doctoral thesis/dissertation at a DOE lab
NSF	[Various]	U.S. Citizens, graduate students	[Various]	[Various]	List of opportunities for graduate students
NOAA	Various fellowship and internship opportunities with NOAA	Undergraduate and graduate students	ENVE	[Various]	List of current fellowship and internship opportunities that are available to students through NOAA
NASA	Training grants to MS and Ph.D. students	U.S. Citizens	MAE	[Various]	Supports graduate students to contribute to NASA's goal to create innovative new space technologies. Opportunity to work collaboratively with a NASA subject matter expert
NASA	Internship and fellowship opportunities	High school through graduate students (U.S. citizens)	MAE	[Various]	Short term opportunities (mostly internships) to work on projects that impact NASA's mission.
AWIS	[Various]	[Various]	[Various]	[Various]	List of opportunities for international graduate students.

Note. Updated July 2019.

Table E-9. Job search tools.

Search Engine	**Focus**	**Search Engine filters**	**Features**
AcademicKeys	All fields	Job category, academic field, state, country, online or remote positions	Can search by discipline, community colleges, staff, and adjuncts
AERA	Education focused	Job function, job type, fellowships, state	Can search for academic and non-academic positions in higher education. It also lets you search specifically for postdoctoral positions and fellowships.
AggieHandshake	All fields	Position type, Location, Work authorization, Industry, major, employer	Search engine specific to USU students and alumni. All types of jobs are posted, including postdocs and academic positions. Can post profile, classes, and organizations.
AIAA	Engineering/ Aerospace engineering	Location, discipline, level, type, education	Aerospace focused jobs. Lists faculty, postdoctoral positions, industry, and government
AIChE	Engineering/ Chemical engineering focused	Industry, position type, Location	Chemical and biological engineering focused jobs. Lists faculty, postdoctoral positions, industry, and government
ASCE	Engineering/ Civil Engineering focused	Location, discipline, level, type, education	Mostly focused on non-academic jobs. Post-doctoral positions included. Can search for jobs specifically requiring a doctorate.
ASEE	Tenure and non-tenure track engineering job postings, admin, post-docs	No filters, just listings.	Small number of higher-ed engineering positions by field.
ASME	Engineering/ Mechanical Engineering focused	Category, employer, location, job title	Focus on non-academic mechanical engineering jobs. Faculty positions listed.

Table E-9 continued

Chronicle Vitae	All fields	Position type, location, date posted, institution type, employment type	Includes jobs outside of academia. Can search up to a 150-mile radius around a location.
HigherEd Jobs	All fields	Category (e.g., faculty, admin), location, type of school (e.g., four-year institution), type of job (e.g., adjunct, diversity and inclusion)	Also includes non-academic positions, executive positions.
IEEE	Engineering/ Electrical Engineering focused	Category, location, company name, job title	Electrical engineering focused jobs. Lists faculty, postdoctoral positions, industry, and government
Indeed	All fields	Location, Salary, position type, company, experience level	Allows you to upload your resume, search salaries, and read company reviews.
Inside Higher Ed	All fields	Location, type of job, institution type, employer type, jobs outside of HE	Can browse faculty, administration, and jobs outside higher education jobs. You can specifically look for post docs and Alt-Academic jobs.
LinkedIn	All fields	Location, company, various	Professional networking site. Searching alumni connections to employers. The website will suggest job posting to you based upon your skills and interests.
USA Jobs	All fields	Location, student status, armed forces, hiring path, salary, work schedule, offers relocation assistance, security clearance, travel percentage	Highly specific and detailed database for federal government jobs.

APPENDIX F: ADDITIONAL TABLES AND FIGURES

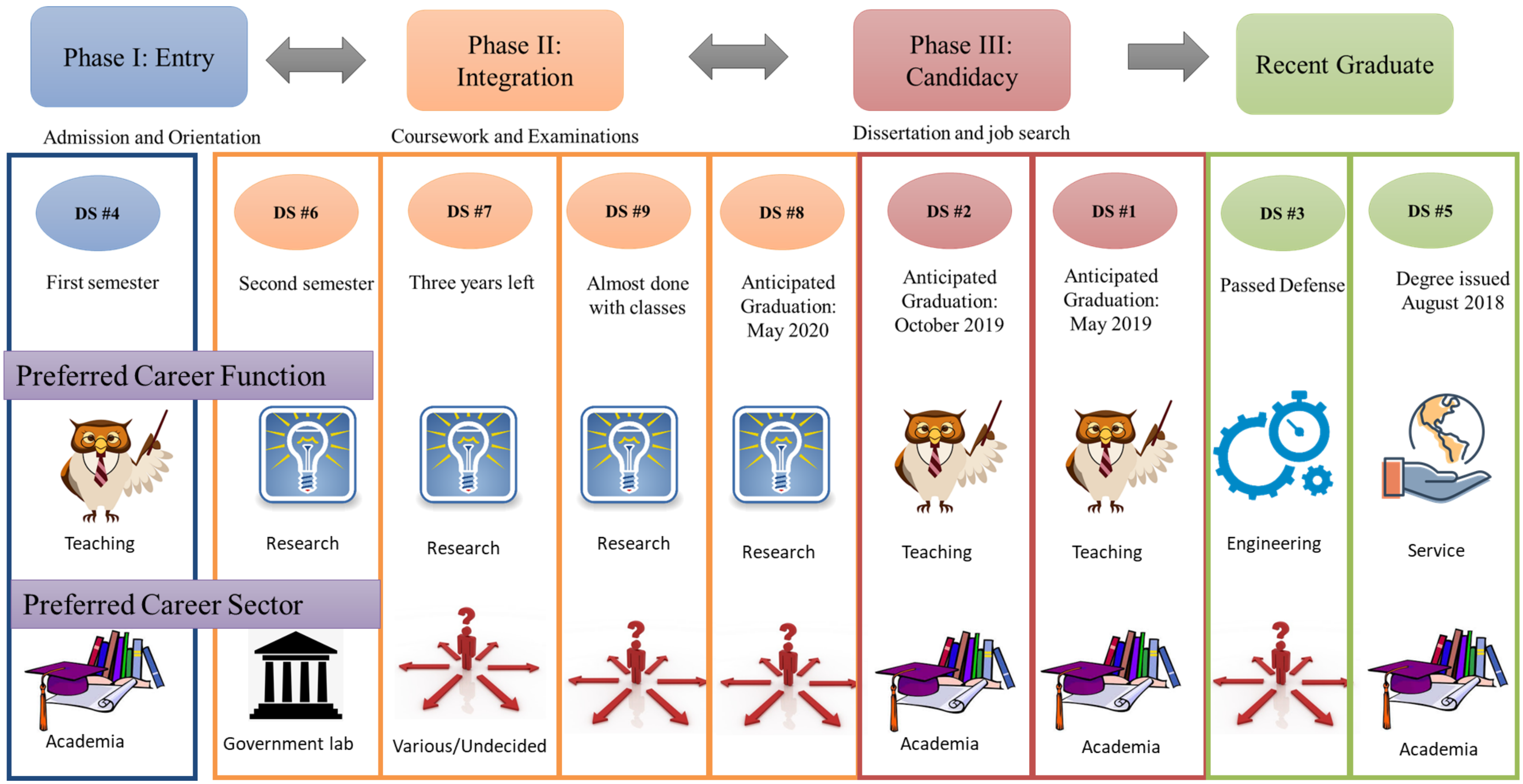

Figure F-1. Summary of participants' phase of development, preferred career function, and preferred career sector.

Table F-1. Job fit characteristic averages by career function and phase of doctoral development.

Job Fit Characteristic	Career Function			Phase of Doctoral Development		
	Research	**Teaching**	**Other**	**Entry**	**Integration**	**Candidacy & Recent Graduates**
Avg. # of Job Fit codes per participant	19	20	24	23	19	21
Type of Work	5	3	3	3	5	3
Location	4	3	4	5	4	3
Work-life Balance	4	4	3	5	4	3
Work Culture	2	1	7	2	2	4
Financial Considerations	2	2	1	4	2	1
Helping Others	0	2	3	1	0	3
Flexibility	1	1	1	2	1	1
Job Prestige	0	2	0	0	0	1
Independence	1	1	1	1	1	1
Commute & Logistics	1	0	2	0	1	1
Promotion & Career Trajectory	1	1	1	0	1	1

Note. Codes were averaged among participant groups and rounded to the nearest whole number.

Table F-2. *A priori* skill code averages by career function and phase of doctoral development.

Skill Type	**Career Function**			**Phase of Doctoral Development**		
	Research	**Teaching**	**Other**	**Entry**	**Integration**	**Candidacy & Recent Graduates**
Average # of Skill Codes per Participant	25.3	24.3	32.0	25.0	25.3	28.0
Technical	5.0	6.0	7.5	1.0	5.0	8.0
Communication	6.0	4.0	4.5	5.0	6.0	4.0
Teaching	1.5	6.3	5.0	6.0	1.5	5.8
Working independently	4.8	2.3	0.0	2.0	4.8	1.3
Problem solving	2.3	1.3	2.0	4.0	2.3	1.0
Critical and analytical thinking	2.3	0.0	3.5	0.0	2.3	1.8
Organizational Culture and Ethics	1.0	1.7	3.0	2.0	1.0	2.3
Leadership	0.0	1.7	3.0	4.0	0.0	1.8
Securing Funding	1.8	0.7	1.0	1.0	1.8	0.8
Interpersonal	0.3	0.3	1.0	0.0	0.3	0.8
Teamwork and Collab	0.5	0.0	0.5	0.0	0.5	0.3
Economic and Commercial	0.0	0.0	1.0	0.0	0.0	0.5

Note. Codes were averaged among participant groups and rounded to the nearest whole number.

Table F-3. Emergent tactic code averages by career function and phase of doctoral development.

Tactic	Career Function			Phase of Doctoral Development		
	Research	**Teaching**	**Other**	**Entry**	**Integration**	**Candidacy & Recent Graduates**
Avg. # of Tactic Codes per participant	27.5	24.3	35.0	23.0	27.5	30.0
Flexibility	4.8	5.3	5.0	0.0	4.8	5.8
Using Career Resources	4.8	3.0	6.5	3.0	4.8	4.3
Networking	2.3	4.7	7.5	5.0	2.3	5.8
Actively seeking knowledge about jobs	5.0	2.0	4.0	6.0	5.0	3.0
Actively seeking skill development	3.0	3.0	3.5	2.0	3.0	3.3
Marketing self	2.3	0.7	3.5	3.0	2.3	2.0
Pursuing Ph.D. to qualify for desired employment	2.5	2.3	0.5	1.0	2.5	2.0
Showing confidence	1.3	0.7	1.5	0.0	1.3	1.0
Self-funding	1.3	0.3	2.0	1.0	1.3	1.0
Actively applying to jobs	0.5	1.0	0.0	1.0	0.5	0.5
Navigating departmental politics/culture	0.0	0.7	1.0	1.0	0.0	1.0
Survival	0.0	0.7	0.0	0.0	0.0	0.5

Note. Codes were averaged among participant groups and rounded to the nearest whole number.

Figure F-2. Screenshot of MAXQDA 2018's code matrix browser (VERBI Software, 2017) of emergently coded tactics coding frequency by participant.

Table F-4. Emergent job fit code averages by career function and phase of doctoral development.

Tactic	Career Function			Phase of Doctoral Development		
	Research	**Teaching**	**Other**	**Entry**	**Integration**	**Candidacy & Recent Graduates**
Avg. # of Job Fit codes per participant	19.3	20.3	23.5	23.0	19.3	21.3
Type of Work	5.0	3.0	3.0	3.0	5.0	3.0
Location	4.3	3.3	3.5	5.0	4.3	3.0
Work-life Balance	3.5	4.3	2.5	5.0	3.5	3.3
Work Culture	1.8	1.3	7.0	2.0	1.8	4.0
Financial Considerations	1.8	2.3	1.0	4.0	1.8	1.3
Helping Others	0.3	2.0	3.0	1.0	0.3	2.8
Flexibility	0.5	1.0	1.0	2.0	0.5	0.8
Job Prestige	0.3	1.7	0.0	0.0	0.3	1.3
Independence	0.8	0.7	0.5	1.0	0.8	0.5
Commute & Logistics	0.5	0.0	1.5	0.0	0.5	0.8
Promotion & Career Trajectory	0.8	0.7	0.5	0.0	0.8	0.8

APPENDIX G: CURRICULUM VITAE

CURRICULUM VITAE

LAURA GELLES

Ph.D. Research Assistant
Engineering Education
Utah State University
Email: laura.gelles@usu.edu
Phone: 775-354-6058

EDUCATION

Utah State University
2016-present. Engineering Education Ph.D. program in progress.
Dissertation: Career Paths and Resources of Domestic Engineering Doctoral Students
Advisor: Dr. Idalis Villanueva
Committee: Dr. Idalis Villanueva, Dr. James Morales, Dr. V. Dean Adams, Dr. Scott Bates, Dr. Wade Goodridge.
GPA: 3.95/4.0
Expected graduation date: August 2019

University of North Dakota
2013-2015. MS in Environmental Engineering
Thesis: Using Geochemical Modeling to Estimate Electron Donor Contributions for Denitrification in the Oruanui Ignimbrite near Lake Taupo, NZ
Committee: Dr. Scott Korom, Dr. Michael Mann, and Dr. Phillip Gerla
GPA: 3.96/4.0

University of Nevada, Reno
2006-2011. BS in Environmental Engineering.
GPA: 3.06/4.0

RESEARCH ACTIVITIES

Utah State University, Logan, UT
January 2016 – Present
Graduate Research Assistant

- Researching and conducting a participatory action research mixed methods study to explore ethical mentoring strategies and links to tokenism for female graduate students and faculty in science and engineering.
- Engaging in mixed-method survey design, construction, and validation to assess hidden curriculum in engineering programs.
- Researched mental health resources and issues for graduate students resulting in creation of mental health resources webpage, inclusion in orientation material, and greater privacy options for graduate students seeking mental health care at Utah State University.

University of North Dakota, Grand Forks, ND
August 2013 – August 2015
Graduate Research Assistant

- Researched electron donors for denitrification and the geochemical effects of denitrification in an igneous environment as a mitigation of nutrient inputs to a nitrogen-limited lake in New Zealand.
- Used geochemical modeling and groundwater statistics resulting in completion of a thesis.
  Thesis: Using Geochemical Modeling to Estimate Electron Donor Contributions for Denitrification in the Oruanui Ignimbrite near Lake Taupo, NZ
  Advisor: Dr. Scott Korom

REFEREED JOURNAL PUBLICATIONS

- **Gelles, L**., Villanueva, I., & Di Stefano, M. (2019). "Mentoring is ethical, right?": Women graduate students and faculty in science and engineering speak out. *International Journal of Gender, Science, and Technology. Special Issue: Gender and Intersectionality in Engineering*, In Press.
  Villanueva, I., Di Stefano, M., **Gelles, L**., Vicioso, P., Benson, S., & Carothers, T. (2018). An intersectional and multi-modal approach to explore the verbal responses and electrodermal activities of science and engineering women to tokenism and research equity. *Contemporary Educational Psychology. Special Issue: Race-Reimagining Psychology Research: Investigating Constructs through the Lens of Race and Culture*, Under Review.
- Villanueva, I., Di Stefano, M., **Gelles, L**., Youmans, K., & Hunt, A. (2018). Development and Validation of a Mixed-Methods Vignette Survey to Explore Hidden Curriculum in Engineering. *Journal of Engineering Education*, Under Review.

REFEREED CONFERENCE PROCEEDINGS

- **Gelles, L**., Youmans, K., & Villanueva, I. Hidden curriculum advocacy for engineering graduate students. *American Society of Engineering Education 2019 CoNECD Conference*, Arlington, VA. April 14-17, 2019.
- Villanueva, I., Di Stefano, M., **Gelles, L**., & Youmans, K. Hidden curriculum awareness: A qualitative comparison of Engineering faculty, graduate students, and undergraduates. *World Engineering Education Global Engineering Dean's Council 2018 Conference*, Albuquerque, NM November 12-16, 2018.
- Villanueva, I., Di Stefano, M., **Gelles, L**., & Youmans, K. Exploring how engineering faculty, graduates, and undergraduates evaluate hidden curriculum via emotions and self-efficacy. *Northern Rocky Mountain Educational Research Association Conference*, Salt Lake City, UT, October 17-19, 2018.
- **Gelles, L**., Villanueva, I., & Di Stefano, M. Perceptions of ethical behavior in ethical mentoring relationships between women graduate students and faculty in science and Engineering, *Proceedings of the American Society of Engineering Education Annual Conference and Exposition*, *Engineering Ethics Division*, Salt Lake City, UT, June 24-27, 2018.
- Villanueva, I., **Gelles, L**., M. Di Stefano, Smith, B., Tull, R., Lord, S., Benson, L.,

Hunt, A., & Riley, D. What does hidden curriculum in engineering look like and how can it be explored? *Proceedings of the American Society of Engineering Education Annual Conference and Exposition*, *Minorities in Engineering Division*, Salt Lake City, UT, June 24-27, 2018.

ENGINEERING/TECHNICAL REPORTS

- Bellon, W., McLean, J., Goodridge, W. H**.**, **Gelles, L**., and DuPont, R. (2018). UDOT Maintenance Site Detention and Retention Pond Water Report, Prepared for UDOT, a joint venture, Salt Lake City, UT. Utah State University, Utah Water Research Laboratory USU Report.
- **Gelles, L**., Goodridge, W. & McClean, J. (2017). Water Quality Analysis of UDOT Maintenance Site Detention and Retention Ponds. Presentation to UDOT Maintenance Team. Logan, UT February 28, 2017.
- Gelles, L. (2016). Chino Discharge Permit- 214/484 Monitoring Well Network Evaluation and Optimization. Freeport-McMoRan Intern Conference, University of Arizona, Tucson, AZ, July 29, 2016.

REFEREED PRESENTATIONS (presenter is underlined)

- Gelles, L., Villanueva, I., and Di Stefano, M. Perceptions of ethical behavior in ethical mentoring relationships between women graduate students and faculty in science and Engineering, *Proceedings of the American Society of Engineering Education Annual Conference and Exposition*, *Engineering Ethics Division*, Accepted, Salt Lake City, UT, June 24-27, 2018.
- Villanueva, I., Gelles, L., M. Di Stefano, B. Smith, R. Tull, S. Lord, L. Benson, A. Hunt, and D. Riley. What does hidden curriculum in engineering look like and how can it be explored? *Proceedings of the American Society of Engineering Education Annual Conference and Exposition, Minorities in Engineering Division*, Accepted, Salt Lake City, UT, June 24-27, 2018.
- Gelles, L., Villanueva, I., Di Stefano, M. (2018) *Hidden Players of Ethical Mentoring for Women Graduate Students and Faculty in Science and Engineering*. Presented at the American Educational Research Association (AERA) Annual Meeting in New York City, NY, April 13-17, 2018.
- Gelles, L., Korom, S., and Hadfield, J. (2016). *Geochemical modeling of electron donors involved in denitrification in the Lake Taupo catchment*. 56th New Zealand Hydrological Society Conference: Water Infrastructure & the Environment. Millennium Hotel, Queenstown, New Zealand, November 28-December 2, 2016.

REFEREED POSTER PRESENTATIONS (presenter is underlined)

- Gelles, L., Villanueva, I. (2019). Career prospects and resources of engineering doctoral students, 95th annual American College Personnel Association Conference. Boston, MA. March 3rd-6th, 2019.
- Gelles, L., Di Stefano, M., Villanueva, I. (2017). Hidden Players of Ethical

Mentoring for Women Graduate Students in Science and Engineering. 10th Annual Mentoring Conference, A Decade of Cultivating an Inclusive Mentoring Community: Developmental Networks for Innovation, Achievement, and Transformation. Albuquerque, NM. October 23rd-27th, 2017.

- Gelles, L. (2017). Mental Health Needs and Resources for Graduate Students. 10th Annual Mentoring Conference, A Decade of Cultivating an Inclusive Mentoring Community: Developmental Networks for Innovation, Achievement, and Transformation. Albuquerque, NM. October 23rd-27th, 2017.
- Gelles, L. & Korom, S. (2014). Using Geochemical Modeling to Determine Electron Donor Contributions for Denitrification near Lake Taupo. ND EPSCoR/IDeA State Conference. Grand Forks, ND.

NON-REFEREED POSTER PRESENTATIONS (presenter is underlined)

- Villanueva, I., Gelles, L., Vicioso, P., Di Stefano, M., & Baisley, A. (2017). Ethical Mentoring: Perspectives and Responses of Female Graduate Students and Faculty in Science and Engineering. Center for Women and Gender Meeting. Utah State University. Logan, UT. March 23, 2017.
- Gelles, L. & Villanueva, I. (2016). Integrating Sustainability into an "Introduction to Engineering" course. Workshop. *Destinations: Planetary Thinking in the Curriculum*." Utah State University.

AWARDS

- 2018 NRMERA Distinguished Paper Award—*Northern Rocky Mountain Educational Research Association 36th Annual Conference*
- 2018 ASEE Engineering Ethics Division Best Diversity Paper—*2018 ASEE National Conference*
- 2018 Graduate Researcher of the Year—*Department of Engineering Education at Utah State University*
- 2017 Graduate Student Instructor of the Year for the College of Engineering—*Office of Research and Graduate Studies at Utah State University*
- 2017 Graduate Student Instructor of the Year—*Department of Engineering Education at Utah State University*

POLICY EXPERIENCE

Progressive Policy Institute, Washington D.C.

February 2019- June 2019

Education Policy Intern

- Researched, wrote blog-posts and policy briefs, and assisted the educational team for the Reinventing America's Schools project, which advocates for a 21st century model of education for K-12 students that focuses on accountability and autonomy.
- Helped coordinate events that brought local stakeholders together so that they could implement the model in their respective districts.

TEACHING ASSISTANT EXPERIENCE

Qualitative Methods in Engineering Education (EED 7040)
Spring 2018
Utah State University

- Developed assignments and content on developing research questions, methodologies, research design elements including research ethics and data collection, and first and second cycles of coding in qualitative research.
- Acted as an advocate and translator for graduate student peers to help ease the transition of quantitatively inclined engineering students to a qualitative research paradigm.

Introduction to Engineering (ENGR 1500)
Fall 2016 and Spring 2017
Utah State University

- Developed and delivered content for lecture on professional ethics, introduction to civil and environmental engineering, problem solving, and other assignments and lectures.
- Researched history and types of introduction to engineering courses and synthesized information to help instructor develop course outline.

PROJECT EXPERIENCE

Utah Department of Transportation (UDOT) Project
August 2016 – July 2017
Utah State University
Project Manager

- Managed and mentored a team of undergraduate researchers to develop a filtering system for the reuse of retention/detention ponds at UDOT maintenance sheds for brine-making operations with a focus on total suspended solids, metal, and petroleum product contaminants.
- Created sampling plan designed for quality assurance and statistical analysis, which included triplicate samples, blanks, preservation, and reduction of sample contamination.
- Coordinated between principle investigator, UDOT, Utah Water Research Laboratory, and undergraduates to collect and analyze water samples at ten UDOT maintenance sites with a focus on quality control and safety.

Environmental Engineering Faculty Sustainability Values Project
February 2016 – May 2016
Utah State University

- Used a qualitative case study methodology to investigate what values of sustainability environmental engineering faculty hold and how they integrate sustainability into their curriculum.
- Conducted qualitative, semi-guided interviews of two participants, and transcribed and coded data using MAXQDA.

INDUSTRY EXPERIENCE

Freeport McMoRan, Chino Mine, NM
June 2016 – August 2016

Environmental Engineering Intern

- Evaluated the groundwater monitoring network for two discharge permits in the Chino South Mine Area using geochemistry data correlations and groundwater statistics in order to optimize sampling frequency and eliminate redundant wells.
- Used EPA modeling program MAROS to help New Mexico Mine Operations build a case to present to the New Mexico Environment Department in order to reduce groundwater sampling burden.

Freeport McMoRan, Oro Valley, AZ
May 2014 – August 2014

Environmental Engineering Intern

- Developed standard operating procedures for Alternate Heap Leach Neutralization (AHLN) tank test and tank sediment dissection including quality control measures for adequate statistical analysis of effluent samples.
- Oversaw and implemented AHLN tank test which included: daily effluent sampling, quality assurance, geochemical data analysis, and troubleshooting which culminated in a presentation and report for Life Cycle Analysis team.

TRAINING AND CERTIFICATIONS

- Social and Behavioral Responsible Conduct of Research Course | September 2017
  Collaborative Institutional Training Initiative (CITI)
- Groundwater Statistics for Environmental Project Managers | July 2017
  Interstate Technology and Regulatory Council
- 24-hour Mine Safety & Health Administration (MSHA) training | June 2016
- Social and Behavioral Research | April 2016
  Collaborative Institutional Training Initiative (CITI)
- E.I.T. certification | April 2011
  Nevada State Board of Professional Engineers and Land Surveyors

PROFESSIONAL SOCIETY MEMBERSHIPS

- American Educational Research Association (AERA)
- American College Personnel Association (ACPA)
- American Society of Engineering Education (ASEE)
- Society of Women Engineers (SWE)